CENTRAL OREGON LANDWATCH

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April 19, 2022

Hearings Officer
Deschutes County Community Development
117 NW Lafayette Ave.
Bend, OR 97701

Delivered by hand

re: **File No: *247-21-001043-PA, 247-21-001044-ZC***
Plan amendment from Agriculture to Rural Residential Exception Area, and zone change

Dear Hearings Officer,

On behalf of Central Oregon LandWatch, thank you for the opportunity to comment on the above-referenced applications. We respectfully urge the Hearings Officer to deny these proposals for the reasons outlined below.

General Comments
The subject property was correctly designated as agricultural land and is correctly zoned for exclusive farm use. The subject property is predominantly land capability Class VI as determined by the U.S. Natural Resources Conservation Service (NRCS) and is thus agricultural land as a matter of law. Statewide Planning Goal 3, OAR 660-015-0000(3); OAR 660-033-0020(1)(a); DCC 18.04.030. The property qualifies as agricultural land under the plain text of Deschutes County code DCC 18.04.030, which implements Goal 3 and OAR 660-033-0020(1)(a). DCC 18.04.030 provides:

> "Agricultural Land" means lands classified by the U.S. Natural Resources Conservation Service (NRCS) as predominantly Class I-VI soils, and other lands in different soil classes which are suitable for farm use, taking into consideration soil fertility, suitability for grazing and cropping, climatic conditions, existing and future availability of water for farm irrigation purposes, existing land use patterns, technological and energy inputs required, and accepted farming practices. Lands in other classes which are necessary to permit farm practices to be undertaken on adjacent or nearby lands shall be included as agricultural lands in any event."

The Hearings Officer lacks the authority to approve the proposed plan amendment and zone change. Statewide Planning Goal 3 requires that agricultural lands be preserved and maintained for farm use. OAR 660-015-0000(3). The subject property is agricultural land by definition pursuant to the plain language of Goal 3, Deschutes County Code, and Oregon Administrative Rule. The proposals cannot be approved without an exception to Goal 3, but no exception to Goal 3 has been sought, and if an exception were sought, the subject property would not qualify. Because the applicable law forbids the proposed changes, the applications must be denied. Our specific comments are below.

1. ***DCC 18.04.030; OAR 660-033-0020(1)(a); OAR 660-015-0000(3); Goal 3; Request official notice of USDA NRCS Upper Deschutes River Area Soil Survey***

LandWatch requests the Hearings Officer to take official notice of a true and correct copy of the U.S. Department of Agriculture, NRCS Soil Survey of the Upper Deschutes River Area, Oregon, including parts of Deschutes, Jefferson, and Klamath Counties, 284 pp. The Upper Deschutes River Area, Oregon Soil Survey is attached as Exhibit A.

LandWatch also requests the Hearings Officer to take official notice of the soils map with legend and the land capability classification of the subject property attached as Exhibits B and C. These exhibits are true and correct copies of the portions of the official USDA NRCS Upper Deschutes River Area Soil Survey depicting the subject property.[1]

These materials are produced and maintained as public records and are published as official publications of the U.S. Department of Agriculture. They contain information the accuracy of which cannot reasonably be questioned, and so are appropriate subjects for judicial notice. These materials from the U.S. Department of Agriculture, NRCS Upper Deschutes River Area Soil Survey are designed to assist the Hearings Officer in determining what the law regarding the definition of agricultural land in DCC 18.04.030, OAR 660-033-0020(1)(a), OAR 660-015-0000(3), and Statewide Planning Goal 3 is or should be.

[1] https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. accessed April 19, 2022.

The official NRCS Upper Deschutes River Area Soil Survey relates to the content of law and policy on the definition of "agricultural land" in Oregon and does not concern only the parties in the case at bar. The Hearings Officer is requested to take official notice of the NRCS Upper Deschutes River Area Soil Survey and the attached excerpts thereof as legislative facts. *State v. O'Key*, 321 Or. 285, 309 n. 35, 899 P.2d 663 (1995) ("When a court, in determining what the law - statutory, decisional, or constitutional - is or should be, takes judicial notice of certain facts, it is taking judicial notice of legislative facts.")

2. ***ORS 215.211; OAR 660-033-0030(5)(a); OAR 660-033-0030(5)(e)***

The Applicant significantly misinterprets OAR 660-033-0030(5) which provides:

> (a) More detailed data on soil capability than is contained in the USDA Natural Resources Conservation Service (NRCS) soil maps and soil surveys may be used to define agricultural land. However, the more detailed soils data shall be related to the NRCS land capability classification system.
>
> *****
>
> (e) This section and OAR 660-033-0045 *authorize* a *person* to obtain additional information for use in the determination of whether a lot or parcel qualifies as agricultural land, but do not otherwise affect the process by which a county determines whether land qualifies as agricultural land as defined by Goal 3 and OAR 660-033-0020. Emphasis added.

Pursuant to the interpretive structure established by the Supreme Court in *PGE v. Bureau of Labor and Industries*, 317 Or 606, 859 P2d 1143 (1993), proper interpretation of an administrative rule begins by reviewing its text in context, with the paramount goal of discerning legislative or agency intent.

The context of OAR 660-033-0030(5)(a) is provided in part by OAR 660-033-0030(5)(e), which states that OAR 660-033-0050 authorizes a "*person*" to obtain additional information. The rule regulates *persons*, imposing an obligation on them to use only certain kinds of information if additional information is obtained. OAR 660-033-0050 does not regulate counties at all, it regulates persons who wish to provide certain information. OAR 660-033-0050(e) explicitly states that the section does not affect the process by which a county determines whether land qualifies as

agricultural land as defined by Goal 3 and OAR 660-033-0020. Applicant misinterprets OAR 660-033-00050, which by its plain text "do[es] not otherwise affect the process by which a county determines whether land qualifies as agricultural land as defined by Goal 3 and OAR 660-033-0020."

Likewise ORS 215.211 regulates the behavior of persons who wish to provide information. ORS 215.211(1) ("If *a person* concludes..."). It constrains such a person to only use a DLCD-certified source of information ("*the person* must request that the Department of Land Conservation and Development arrange for the assessment"). ORS 215.211 explicitly does not affect the proper interpretation and application of OAR 660-033-0020 (land in Eastern Oregon classified by the NRCS as Class I-VI is agricultural land). ORS 215.211(5) provides:

> "This section authorizes a *person* to obtain additional information for use in the determination of whether land qualifies as agricultural land, but this section *does not otherwise affect* the *process by which* a county determines whether *land qualifies as agricultural land*." Emphasis added.

Applicant misinterprets OAR 660-033-0050 and ORS 215.211. Applicant ignored the requisite *PGE* interpretive structure according to which statutes and rules must be interpreted in context, with the objective of discerning legislative intent. In context, the rule and statute do not have the meaning Applicant tries to give them. DCC 18.04.030, above, which mirrors and presumably implements the statutory and rule definitions of "agricultural land" in Goal 3 and OAR 660-033-0020(1), provides that there are two broad classes of lands encompassed in the definition of "agricultural land." The first is that class of lands which are:

> "Classified by the U.S. Natural Resources Conservation Service (NRCS) as predominantly Class I-VI soils."

The subject property falls into this class.

The second is that class of lands which are:

> "[O]ther lands in different soil classes which are suitable for farm use, taking into consideration soil fertility, suitability for grazing and cropping, climatic conditions, existing

> and future availability of water for farm irrigation purposes, existing land use patterns, technological and energy inputs required, and accepted farming practices."

As explained above, the U.S. Department of Agriculture NRCS Upper Deschutes River Area Soil Survey, Exhibit A, is an official document produced and maintained as a public document. This material is produced and maintained as a public record and contains information the accuracy of which cannot reasonably be questioned. The statutory right of a person pursuant to ORS 215.211 to provide additional information, but only of a certain type, does not change the Goal 3 definition of agricultural land, nor affect the meaning or significance of the official U.S. Department of Agriculture NRCS Upper Deschutes River Area Soil Survey.

The information obtained by a person referred to in ORS 215.211 or OAR 660-033-0050(a) can assist a county in determining whether land in the second class is *also* agricultural land. It cannot alter the obligation placed on Oregon counties to follow their own laws and the laws of the state of Oregon, which provide by their plain language that land that is classified *by the NRCS* as Class I-VI in Eastern Oregon is agricultural land. The subject property already meets the definition of agricultural land. Applicant's additional information is irrelevant and should be disregarded by the Hearings Officer.

3. ***Goal 3; OAR 660-015-0000(3); OAR 660-033-0020(1)(a); DCC 18.04.030; Subject property is agricultural land as a matter of law.***

The Applicant misconstrues the applicable law and directs evidence toward the wrong standard in arguing the land is not agricultural land while agreeing the land has been classified by the NRCS as predominantly Class VI. Applicant's Burden of Proof, Appendix A, NRCS Soil Map and Map Unit Legend, Eden Enterprises NW Coyner Avenue, Upper Deschutes River Area 63C description.

As shown in the Applicant's Burden of Proof, the NRCS identifies 534.6 acres or 76%, a clear predominance of Applicant's property, as map unit 63C, and classifies such land as agricultural land capability Class VI. See Burden of Proof, Appendix A.

The plain language of Goal 3, OAR 660-015-0000(3), OAR 660-033-0020(1)(a), and DCC 18.04.030 unequivocally provides that land predominantly composed of land capability Class I-VI as classified by the NRCS is agricultural land. Moreover Goal 3, Oregon administrative rule, and the County code broadly define agricultural lands to include "lands in *different* soil classes," "lands in *other* soil classes," or "*other* lands," to distinguish them from "lands classified by the U.S. Natural Resources Conservation Service (NRCS) as predominantly Class I-VI soils," which are agricultural land as a matter of law.

The Applicant could use the property for seasonal grazing with supplemental feeding in the winter, a customary farming practice in Deschutes County. The Applicant could also use the land for the production of chickens, goats, honey, lavender, or any of a multitude of other crops and livestock commonly raised in Deschutes County without irrigation water and on lands of no particular land capability class. There is no evidence to the contrary.

Opponents bear no burden to prove this land meets the definition of agricultural land. Rather, the burden is on the Applicant to show, if it can, that the land does not meet that definition. The Applicant has not met the heavy burden of establishing the land is not suitable for any farm use. If the land did not qualify as agricultural land as a matter of law, nevertheless there is no evidence in the record on which the Hearings Officer could base a finding that the land is not suitable for farm use for the production of livestock or other agricultural commodities that are independent of soil characteristics. The property is agricultural land and the applications require an exception to Goal 3. Since no exception to Goal 3 has been justified, the applications must be denied.

4. ***NRCS Technical Soil Services Handbook; Applicant misuses Order 1 Survey.***

LandWatch requests the Hearings Officer to take official notice of the attached true and correct copy of the NRCS Technical Soil Services Handbook, Section 629. Exhibit D. The NRCS Technical Soil Services Handbook, Section 629 states:

> "Order 1 soil surveys and site-specific data collected are supplements to the official soil survey, but they do not replace or change the official soil survey."

The Applicant's argument is based on an Order 1 soil survey. Applicant Burden of Proof, Appendix A. Applicant argues the Order 1 survey somehow displaces the U.S. Department of Agriculture NRCS Upper Deschutes River Area Soil Survey. Exhibit A. This is false. According to the U.S. Department of Agriculture NRCS Technical Soil Services Handbook Part 629, Order 1 surveys do not replace or change the official soil survey.

The Applicant erroneously states that more detail than the official soil survey is needed to determine whether the subject property is agricultural land. As shown in Exhibit A, the minimum size for the official soil survey's delineations for purposes of management in this area is 5 acres, with an average of 40 acres, while the property is 710 acres, overwhelmingly within the range of accuracy of the NRCS Upper Deschutes Area official soil survey.

The official soil survey for the Upper Deschutes River Area classifies this land as predominantly Class VI. By definition, according to the U.S. Department of Agriculture NRCS Technical Soil Services Handbook 629, an Order 1 survey does not replace or change the NRCS classification of predominantly Class VI.

Conclusion

The land meets the definition of agricultural land as a matter of law. An exception to Goal 3 is required but has not been provided. We respectfully urge the Hearings Officer to deny these applications for the reasons outlined above.

Best regards,

Carol Macbeth
Staff Attorney
Central Oregon LandWatch

United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with United States Department of Agriculture, Forest Service; United States Department of the Interior, Bureau of Land Management; and Oregon Agricultural Experiment Station

Soil Survey of Upper Deschutes River Area, Oregon, including parts of Deschutes, Jefferson, and Klamath Counties

Exhibit A

How to Use This Soil Survey

General Soil Map

The general soil map, which is a color map, 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.

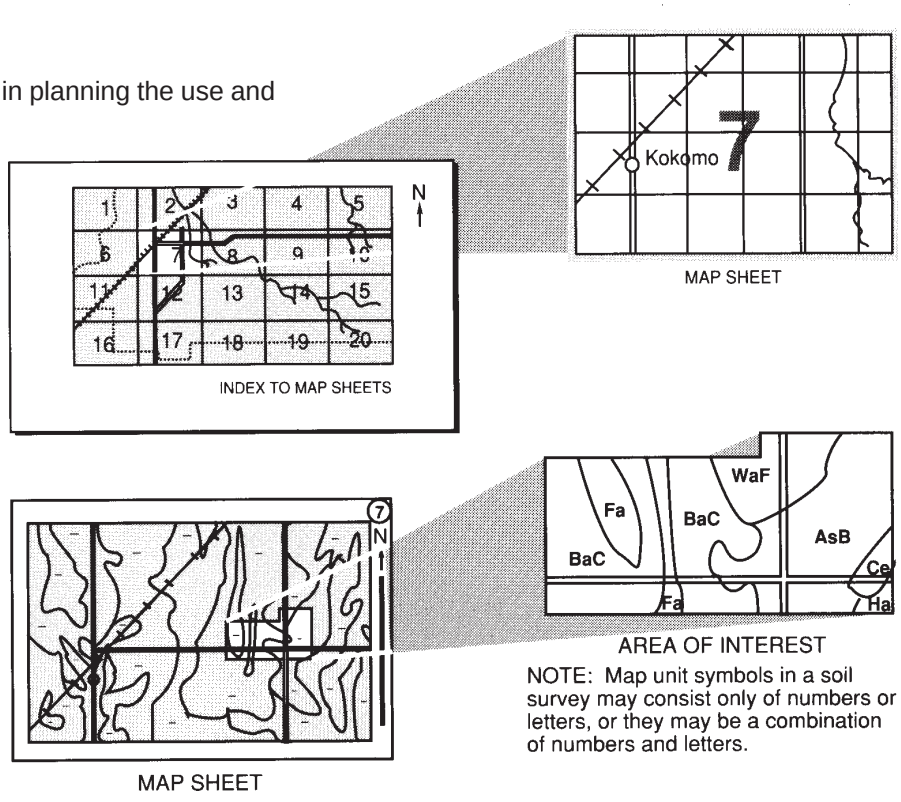
Detailed Soil Maps

The detailed soil maps 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**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit 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.



NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

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 1990. 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 Forest Service, Bureau of Land Management, and Oregon Agricultural Experiment Station. The survey is part of the technical assistance furnished to the Deschutes County, Jefferson County, and Klamath County Soil and Water Conservation Districts. Assistance was provided by the Board of Commissioners for Deschutes and Jefferson Counties.

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.

Cover: Riparian habitat and rangeland along the Crooked River.

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.

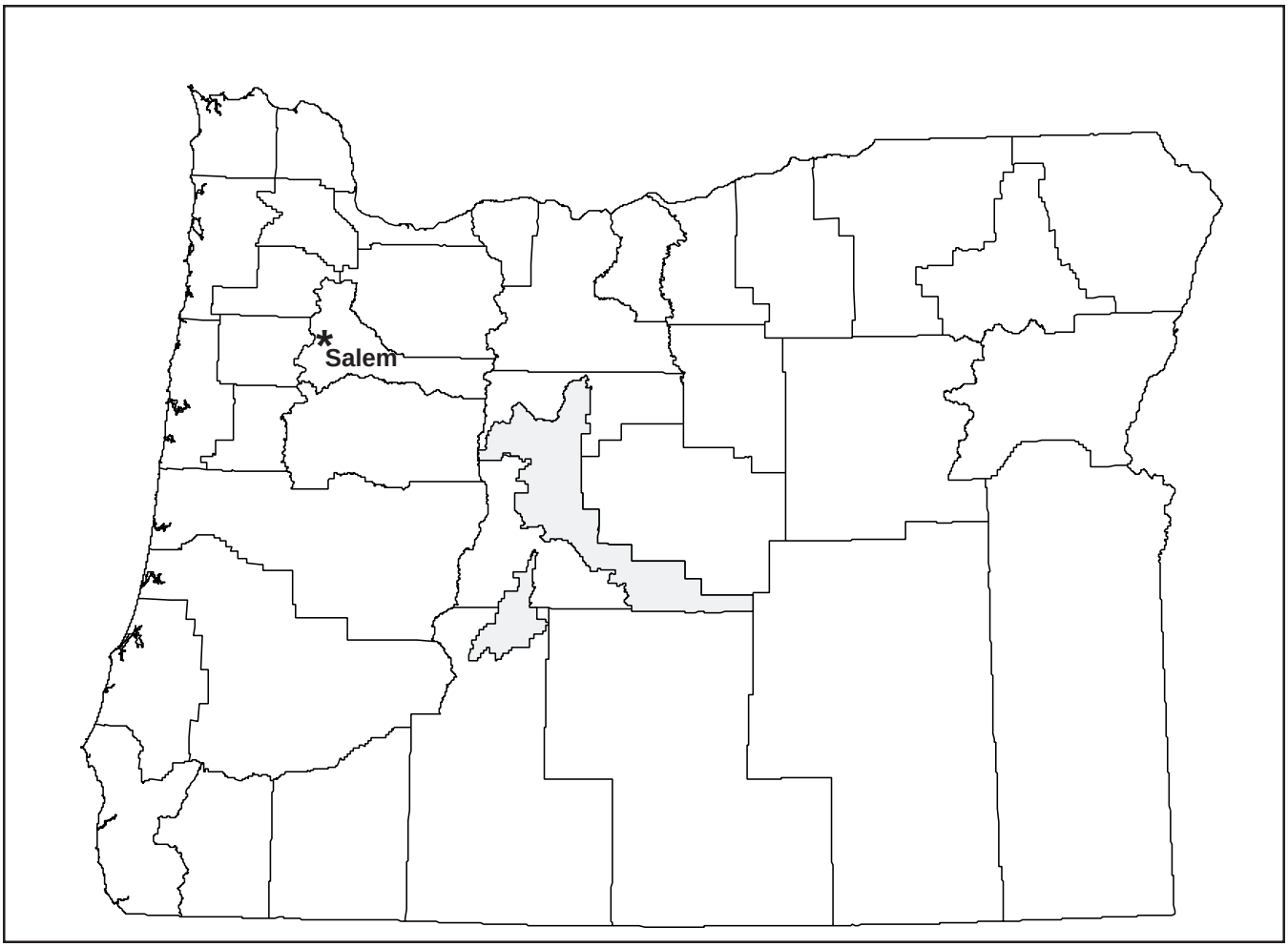
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use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

Soil Survey of Upper Deschutes River Area, Oregon, including parts of Deschutes, Jefferson, and Klamath Counties

By Ron Myhrum and William Ferry, Natural Resources Conservation Service

Fieldwork by William Ferry, Mike Lamkin, Jerry Macdonald, Ron Myhrum, and Aimee Walker, Natural Resources Conservation Service; Terry Brock, Forest Service; and Larry Thomas, Bureau of Land Management

United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with
United States Department of Agriculture, Forest Service; United States Department of the Interior, Bureau of Land Management; and Oregon Agricultural Experiment Station

The Upper Deschutes River Area includes private and public land in parts of Deschutes, Jefferson, and Klamath Counties. The northern part of the survey area is comprised of the western part of Jefferson County (excluding the Warm Springs Indian Reservation). The central part of the survey area is in Deschutes County, and it includes areas of land administered by the Forest Service and the Bureau of Land Management. The southern part of the survey area is an island comprised of the southern part of Deschutes County, near LaPine, extending into the northern part of Klamath County and south to Crescent and Gilchrist. The survey area includes about 1,540,000 acres.

A wide variety of landscapes make up the survey area. In the north is the plateau known as the Agency Plains, adjacent to the Deschutes River canyon. To the south are rolling hills and lava benches with deep gorges incised by the Deschutes and Crooked Rivers. Farther to the south are pumice flats and basins with scattered cinder cones. To the east are the basalt plateaus of the high desert. The western edge is made up of the glaciated toe slopes and valleys of the Cascade Mountains. Elevation ranges from 1,295 feet at the northernmost point in the survey area to 5,545 feet at Three Creek Butte. The average annual precipitation is about 8 to 70 inches.

The survey area includes almost all of the cultivated land in Jefferson and Deschutes Counties and the major population centers in these counties. Bend and Madras, the county seats of Deschutes and Jefferson Counties, respectively, are in the survey area.

Recreation and tourism, wood products, farming and ranching, and manufacturing are the main industries. The survey area is adjacent to or very near three wilderness areas, and there are two ski areas just to the west of the survey area. Several lakes, streams, and rivers are in or near the area.

The major north-south highway on the eastern side of the Cascade Mountains, U.S. Highway 97, passes through LaPine, Bend, Redmond, and Madras. A major east-west artery, U.S. Highway 20, passes through Bend and Sisters. A municipal airport is in Redmond, and airstrips with facilities are in Madras, Bend, and Sunriver. The railroad transects the area, following much the same route as U.S. Highway 97.

This soil survey updates the survey of Deschutes Area, Oregon, published in 1958 *(23)* and the interim survey of Brothers Area published in 1983 *(28)*. It provides additional information and has larger maps, which show the soils in greater detail.

General Nature of the County

This section briefly discusses the history and development, physiography and drainage, and climate of the survey area.

History and Development

When Europeans first saw the area of the Upper Deschutes River, it was occupied by the Warm Springs and Northern Paiute Tribes. Long before that time,

Klamath Lakes Indians had occupied much of what is now the southern part of the survey area. The Molalla Indians from the Willamette Valley area west of the Cascade Mountains seasonally traveled into central Oregon and the Deschutes River area to gather food. The Cayuse and Sahaptin Indians also seasonally migrated into the area from the region that is now northeastern Oregon *(30)*.

A treaty was signed in 1955 that brought the Warm Springs, Paiute, and Wasco Tribes together on the Warm Springs Indian Reservation. The Warm Springs and Wasco Indians had been neighbors (the Wasco Indians occupied the region around The Dalles), had similar cultures, and often intermarried. Both tribes fished, hunted, and gathered roots and berries for sustenance.

The pursuit of beaver pelts brought the first white men to the area of the Deschutes River. "Deschutes" is from the French "Riviere des Chutes," which means the river of the falls. The first white man to see the Upper Deschutes River and central Oregon was Peter Skene Ogden of the Hudson's Bay Company. He and his party set out from the Columbia River late in 1825 and headed up the Deschutes River, trapping as they went. When they came to what is now known as the Crooked River, they ventured upriver, eventually arriving in the John Day River area. They returned in 1826, heading down the White River and crossing the Deschutes River at Sherar's Falls. Again they headed up the Deschutes River to the Crooked River, and after following that channel, ventured into southeastern Oregon. On their return, they became the first white men to see what later became known as Newberry Crater, East Lake, and Paulina Lake *(6)*.

An exploration party under the command of Lt. Robert Williamson was sent west in 1855 to find the best route for a railroad to extend from the Mississippi River to the Pacific Ocean. Included in the party was John Strong Newberry, a physician and naturalist, whose name was given to the crater discovered in 1826. The expedition came from San Francisco by way of Klamath Falls. Their trek led them through the Deschutes River area, and they continued on to the Metolius River and Black Butte areas. They followed the Metolius River to the Cove Palisades and then crossed the Cascade Mountains.

Settlement in the area was discouraged, and in 1856 it was even forbidden by the Federal government because of resistance to the presence of white men. The area to the north and east was settled first, particularly that near Shaniko, which was the end of the line for the railroad.

The Homestead Act of 1862 drew many optimists to the area, and even the high desert to the east was scattered with homesteaders. One by one, however, these would-be ranchers and farmers surrendered the land back to the sagebrush and moved on.

The Madras area was settled in the late 1860's. There was a rumor that a railroad was coming to this area, and settlers were drawn to the area because the soil was more fertile than that near Bend and Redmond.

Irrigation had several small beginnings in the 1870's in the Sisters, Bend, Redmond, and Madras areas. Rights to water from the Deschutes River were filed in the 1890's.

The ill-fated Tumalo Irrigation District was established in 1893, the Swalley Brothers Irrigation District in 1899, and the Arnold Irrigation District in 1904. The Pilot Butte Canal started carrying water in 1904, and it became part of the Central Oregon Irrigation District in 1910. In 1912 the North Canal began transporting water northward to Redmond. The Redmond area received irrigation water in 1906 and the Madras area in 1946. Presently, six irrigation districts use water from the Deschutes River.

Alfalfa, barley, oats, and potatoes were all grown in the earlier days in Deschutes and Jefferson Counties. Presently in Deschutes County, alfalfa is the main crop and there are relatively few acres of potatoes and mint. Almost all other irrigated land in the county is pasture. In Jefferson County, alfalfa, potatoes (mostly seed potatoes), grass seed, carrot seed, mint, and garlic are grown, making it a diverse and significant agricultural area.

Livestock in the survey area historically included only cattle and sheep. Today the livestock operations are comprised of cattle, llamas, horses, and sheep.

Timber land in the area has been bought since as early as 1898; however, until the railway was completed, the importance of lumber to the economy was limited. In 1916 the Shevlin-Hixon Mill was established, and the Brooks-Scanlon Mill was established soon after. According to Phil Brogan, by the late 1920's these mills were producing 500 million board feet of lumber annually and they employed about 2,000 workers. This helped to establish the economic base for Bend and the rest of central Oregon *(7)*. In spite of reduced timber harvesting, the wood products industry is still important to the economy of Deschutes and Jefferson Counties.

The survey area is known for its recreational appeal. Central Oregon offers opportunities for world-class

downhill and cross-county skiing, golfing, fishing, hunting, whitewater rafting, rock climbing, and hiking.

Physiography and Drainage

The approximately 1.5 million acres comprising the survey area includes parts of three major land resource areas—the Upper Snake River Lava Plains and Hills, the Eastern Slope of the Cascade Mountains, and the Malheur High Plateau *(27)*.

Relief is moderate throughout the survey area. The topography of the Upper Snake River Lava Plains and Hills resource area is nearly level to rolling except for the deeply incised canyons of the Deschutes and Crooked Rivers and several widely scattered cinder cones. With the exception of the Deschutes and Crooked Rivers, perennial and intermittent drainageways are lacking because of the limited precipitation and runoff.

The topography of the Eastern Slope of the Cascade Mountains resource area is nearly level to steep. Perennial and intermittent drainageways are numerous because of the precipitation that falls in spring and fall and the continuous runoff from snowmelt.

The topography of the Malheur High Plateau resource area is nearly level to rolling except for the numerous cinder cones that dot the landscape. Perennial and intermittent drainageways are lacking in this resource area because of limited precipitation and runoff.

Most of the survey area is drained by the Deschutes River and its tributaries, which include the Little Deschutes River, Tumalo Creek, Dry River, Squaw Creek, Metolius River, Crooked River, and Willow Creek. Water is a limited resource in the agricultural areas of the survey area because of the limited precipitation, high infiltration rate, and moderate or rapid permeability of the soils. Water from snowmelt is stored in Crane Prairie and Wickiup Reservoirs and is used for irrigation.

Climate

In this survey area, temperature and precipitation are related to changes in elevation. Elevation increases from the northern part of the area near Madras to the southern part near LaPine. The climate for the area was recorded at Madras, Bend, and Chemult during the period 1952 to 1990. The weather station at Chemult is outside the survey area, but the climate is representative of the LaPine area.

Table 1 gives data on temperature and precipitation. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

The average monthly temperature at Madras, Bend, and Chemult is 48, 46, and 42 degrees F, respectively. The average temperature in summer (June, July, and August) is 64, 60, and 53 degrees, respectively. The average temperature in winter (December, January, and February) is 34, 33, and 28 degrees, respectively. The extreme temperatures at all three stations were about 102 degrees for the high and -27 degrees for the low.

Growing degree days, shown in table 1, 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). 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 average annual precipitation is 11 inches at Madras and Bend and 24 inches at Chemult. Most of the precipitation, about 70 percent, falls during November through April. During the driest months, which are July, August, and September, the average monthly precipitation is less than 1 inch. The amount and duration of snowfall in winter is variable, but the southern part of the area receives the highest amounts for the longest duration.

How This Survey Was Made

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, limitations, and management for specified uses. 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.

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 describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. 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. 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. Data are assembled from other sources, such as research information, production records, and field experience of specialists.

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.

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

Survey Procedures

The general procedures followed in making this survey are described in the National Soil Survey Handbook of the Natural Resources Conservation Service. Source material used in the development of the survey includes the soil survey of the Deschutes Area, Oregon, published in 1958 *(23)*; the interim soil survey of the Brothers Area published in 1983 *(28)*; U.S. Geological Survey geologic maps; and the National Cooperative Soil Survey memorandum of understanding between the Natural Resources Conservation Service, the Forest Service, the Bureau of Land Management, and the Oregon Agricultural Experiment Station.

By separating the landscapes into discrete landforms and identifying the dominant soil-forming properties on each landform, predictable soil-landform models became apparent and were the basis for the soil maps and the development of the soil series and map unit descriptions. The soil-landform relationships for this survey area are discussed under the heading “Formation of the Soils.”

The survey area was mapped at two levels of intensity. At the less detailed level, map units are mainly associations and complexes. The average size of the delineations for most management purposes was 160 acres. Most of the land mapped at this level is used as woodland and rangeland. At the more detailed level, map units are mainly consociations and complexes. The average size of the delineations for purposes of management was 40 acres, and the minimum size was 5 acres. Most of the land mapped at the more detailed level is used as irrigated and nonirrigated cropland. Spot symbols were used for contrasting soil types and miscellaneous areas that are too small to be mapped at the same intensity as the surrounding land. Inclusions of contrasting soils or miscellaneous areas are described in the map unit if they are a significant component of the unit.

Soil mapping in the high desert of eastern

Deschutes County and around the Cline Buttes area of western Deschutes County was completed by the Bureau of Land Management in the period 1978 to 1980. Some revision of the original series and map units occurred during this survey to reflect a better understanding of the soils. The Forest Service assisted in the soil mapping of the Sisters and Bend Ranger Districts in the Deschutes National Forest.

Samples for chemical and physical analysis were taken from typical pedons of the major soils in the survey area. The analyses were made at the National Soil Survey Laboratory in Lincoln, Nebraska, and at the Oregon State University laboratory. The analyses provided data used in soil classification and in making interpretations for fertility and erodibility and for engineering and land use planning.

Productivity estimates were made for timber production, rangeland, and crop production. Woodland productivity was estimated by the National Resources Conservation Service and the Forest Service from data gathered at selected forested sites. Rangeland productivity was estimated for plots inside and outside the survey area. Agricultural crop yield data was estimated by the Cooperative Extension Service, Farm Services Agency, and individual farmers.

General Soil Map Units

The general soil map at the back of this publication 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.

Soils on Pumice-Mantled Stream Terraces and Flood Plains

This group consists of one map unit. It makes up about 3 percent of the survey area.

1. Tutni-Sunriver-Cryaquolls

Very deep, somewhat poorly drained to very poorly drained soils that formed in mixed alluvium high in content of ash and in ash and pumice over older alluvium

This map unit is on stream terraces and flood plains in LaPine Basin. Elevation ranges from 4,000 to 5,000 feet. Slopes range from 0 to 3 percent. The mean annual precipitation is 18 to 25 inches, the mean annual air temperature is 40 to 44 degrees F, and the frost-free period is 10 to 50 days.

This unit makes up about 3 percent of the survey area. It is about 40 percent Tutni soils, 30 percent Sunriver soils, and 20 percent Cryaquolls. The rest is soils of minor extent.

Tutni soils are on stream terraces. These soils are more than 60 inches deep to bedrock and are somewhat poorly drained. They have a very dark grayish brown loamy coarse sand surface layer; a mottled, dark grayish brown very gravelly coarse sand substratum; and a very dark grayish brown sandy loam buried layer. Depth to a seasonal high water table is 18 to 48 inches.

Sunriver soils are on stream terraces. These soils are more than 60 inches deep to bedrock and are somewhat poorly drained. They have a very dark gray sandy loam surface layer; a mottled, light brownish gray coarse sand subsoil; and a mottled, very dark gray sandy loam buried layer. Depth to a seasonal high water table is 24 to 48 inches.

Cryaquolls are on flood plains. These soils are more than 60 inches deep to bedrock and are poorly drained and very poorly drained. They have a dark brown silt, silt loam, or gravelly loamy sand surface layer; a very dark gray, mottled sandy loam, loam, silt loam, or loamy sand subsoil; and a very dark gray sand substratum. A seasonal high water table is at the surface to a depth of 24 inches below the surface. These soils are subject to rare flooding.

Of minor extent in this unit are Wickiup soils on stream terraces.

This unit is used mainly as wildlife habitat and pasture and for timber production.

The cold climate of the LaPine Basin and a seasonal high water table restrict these soils for most uses. Lodgepole pine is the principal tree species on the Tutni and Sunriver soils. The seasonal high water table restricts equipment use to summer and increases the risk of windthrow. Designated skid trails should be established to minimize soil compaction. Seedlings adapted to droughtiness in summer should be planted. Soil displacement should be minimized because fertility is highest in the organic layer and the upper mineral layers. Cryaquolls support lush wetland vegetation and are primarily used as wildlife habitat. Some areas are used as native pasture.

The soils in this unit are poorly suited to use as building sites. The seasonal high water table restricts

the installation of standard septic systems. Because of the cold soil temperatures and the coarse texture of the soil material, morphological evidence of seasonal wetness is minimal.

Soils on Pumice-Mantled Lava Plains and Hills

This group consists of two map units. It makes up about 15 percent of the survey area.

2. Shanahan-Steiger

Very deep, somewhat excessively drained soils that formed in ash and pumice over colluvium and older alluvium

This map unit is on lava plains and hills in the LaPine Basin. Elevation ranges from 4,000 to 6,000 feet. Slopes range from 0 to 50 percent, but they dominantly are less than 15 percent. The mean annual precipitation is 18 to 25 inches, the mean annual air temperature is 40 to 44 degrees F, and the frost free period is 10 to 50 days.

This unit makes up about 7 percent of the survey area. It is about 50 percent Shanahan soils and 45 percent Steiger soils. The rest is soils of minor extent.

Shanahan soils are more than 60 inches deep to bedrock and are somewhat excessively drained. These soils have a dark brown loamy coarse sand surface layer, a yellowish brown and brown loamy coarse sand and coarse sand substratum, and a dark brown sandy loam and gravelly sandy loam buried layer. Depth to the buried layer is 20 to 40 inches.

Steiger soils are more than 60 inches deep to bedrock and are somewhat excessively drained. These soils have a dark grayish brown loamy coarse sand surface layer, a pale yellow gravelly coarse sand substratum, and a dark yellowish brown loam buried layer. Depth to the buried layer is 40 to 60 inches or more.

Of minor extent in this unit are Sunriver and Tutni soils on pumice-mantled stream terraces.

This unit is used mainly for timber production and as wildlife habitat.

Lodgepole pine is the dominant tree species in the low, nearly level positions on lava plains, where frost pockets occur. Ponderosa pine is dominant in the higher positions on lava plains, where the risk of frost is lower. Mixed conifers, including ponderosa pine, sugar pine, white fir, and Douglas fir, are on the hills along the western margin of the basin. Windthrow is a hazard because of the coarse texture of the ash and pumice. Practices that minimize soil displacement, compaction, and erosion should be used, especially in the steeper areas.

3. Lapine

Very deep, excessively drained soils that formed in pumice and ash

This map unit is on lava plains and hills in the LaPine Basin. Elevation ranges from 4,200 to 6,000 feet. Slopes range from 0 to 70 percent, but they dominantly are less than 15 percent. The mean annual precipitation is 18 to 25 inches, the mean annual air temperature is 40 to 44 degrees F, and the frost-free period is 10 to 50 days.

This unit makes up about 8 percent of the survey area. It is about 90 percent Lapine soils. The rest is soils of minor extent.

Lapine soils are more than 60 inches deep to bedrock and are excessively drained. These soils have a very dark grayish brown and dark brown gravelly loamy coarse sand surface layer and a very pale brown and light gray gravelly to extremely gravelly coarse sand substratum.

Of minor extent in this unit are Wickiup soils in depressions on stream terraces.

This unit is used mainly for timber production.

Lodgepole pine is the dominant tree species in the low, nearly level positions on lava plains, where frost pockets occur. Ponderosa pine is dominant in the higher positions, where the risk of frost is lower. Mixed conifers, including ponderosa pine, sugar pine, white fir, and Douglas fir, make up the overstory vegetation on the sloping uplands along the western margin of the basin and on Walker Rim. Windthrow is a concern because of the coarse texture of the ash and pumice. Practices that limit soil displacement, compaction, and erosion should be used, especially in the steeper areas. Dry ravel on the steeper slopes may damage seedlings.

Soils on Canyonsides

This group consists of one map unit. It makes up about 4 percent of the survey area.

4. Simas-Ruckles-Lickskillet

Very deep and shallow, well drained soils that formed in loess and colluvium

This map unit is on canyonsides of the Deschutes, Crooked, and Metolius Rivers. Elevation ranges from 1,400 to 3,500 feet. Slopes range from 15 to 80

percent. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 110 to 140 days.

This unit makes up about 4 percent of the survey area. It is about 40 percent Simas soils, 30 percent Ruckles soils, and 15 percent Lickskillet soils. The rest is soils of minor extent.

Simas soils are more than 60 inches deep to bedrock and are well drained. They typically are on toe slopes and are associated with tuff. These soils have a dark grayish brown cobbly loam surface layer and a yellowish brown gravelly clay, cobbly clay, and clay subsoil.

Ruckles soils are 10 to 20 inches deep to bedrock and are well drained. They typically are on middle and upper side slopes and are associated with basalt. These soils have a dark grayish brown extremely cobbly loam surface layer and a brown extremely cobbly clay and cobbly clay subsoil.

Lickskillet soils are 12 to 20 inches deep to bedrock and are well drained. They typically are in the steepest areas of middle and upper side slopes and are associated with basalt. These soils have a dark grayish brown very gravelly loam or very stony sandy loam surface layer and a brown extremely gravelly loam or very cobbly sandy loam subsoil.

Of minor extent in this unit are Clinefalls and Era soils, Fluvents, Redcliff and Redslide soils, and Rock outcrop.

This unit is used as wildlife habitat and for livestock grazing.

The main limitations of this unit are slope and aspect. In areas that have slopes of more than 30 percent, range seeding with ground equipment is impractical and livestock distribution is restricted. The south-facing slopes are less suited to grazing during hot periods in summer. The shallow depth and rock fragments in the soils reduce available soil moisture.

Warm Soils on Lava Plains and Hills

This group consists of six map units. It makes up about 31 percent of the survey area.

5. Deschutes-Stukel-Rock outcrop

Moderately deep and shallow, well drained, sandy loam that formed in volcanic ash; on lava plains

This map unit is on lava plains in the area north of Bend to Juniper Butte. Elevation ranges from 2,500 to 4,000 feet. Slopes range from 0 to 30 percent. The mean annual precipitation is 8 to 12 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost free period is 70 to 100 days.

This unit makes up about 8 percent of the survey area. It is about 30 percent Deschutes soils, 30 percent Stukel soils, and 15 percent Rock outcrop. The rest is soils of minor extent.

Deschutes soils are 20 to 40 inches deep to bedrock and are well drained. They are in depressions among numerous lava blisters on lava plains. These soils have a grayish brown sandy loam surface layer and a light grayish brown sandy loam subsoil.

Stukel soils are 10 to 20 inches deep to bedrock and are well drained. They are along the margins of depressions and on lava blisters. These soils have a grayish brown sandy loam and brown cobbly sandy loam surface layer and a pale brown gravelly sandy loam subsoil.

Of minor extent in this unit are Houstake, Lickskillet, Redcliff, Redmond, Redslide, Searles, Statz, and Tetherow soils.

This unit is used for irrigated cropland and livestock grazing.

Most of this unit is on young lava flows that are characterized by lava blisters, depressions, and rock outcroppings, which restrict irrigation systems and farming operations. There are significant areas that are not restricted by Rock outcrop and can be managed effectively. The sandy loam surface layer is susceptible to wind erosion and should not be left unprotected. The low available water capacity and moderately rapid permeability should be considered in irrigation water management. To minimize runoff and erosion, sprinkler irrigation should be used in areas that have slopes of more than 3 percent. The soils in this unit are very sensitive to overgrazing, and recovery rates can be slow. Pond development is limited by the depth to bedrock and risk of seepage.

6. Gosney-Deskamp-Rock outcrop

Moderately deep and shallow, somewhat excessively drained, stony loamy sand and loamy sand that formed in ash; on lava plains

This map unit is on lava plains east of Bend. It includes areas near Alfalfa that are underlain by alluvium and are used as irrigated cropland. Elevation ranges from 2,500 to 4,000 feet. Slopes range from 0 to 15 percent. The mean annual precipitation is 8 to 12 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 70 to 100 days.

This unit makes up about 8 percent of the survey area. It is about 40 percent Gosney soils, 35 percent

Deskamp soils, and 15 percent Rock outcrop. The rest is soils of minor extent.

Gosney soils are 10 to 20 inches deep to bedrock and are somewhat excessively drained. They are along the margins of depressions. These soils have a grayish brown stony loamy sand surface layer and a grayish brown loamy sand subsoil.

Deskamp soils are 20 to 40 inches deep to bedrock and are somewhat excessively drained. They are in depressions among numerous lava blisters. These soils have a brown loamy sand surface layer and a pale brown gravelly loamy sand subsoil.

Of minor extent in this unit are Clovkamp soils.

This unit is used for livestock grazing and irrigated cropland.

The main limitations of this unit are the loamy sand texture and the depth to bedrock. The soils in this unit are subject to wind erosion if they are left unprotected when applying range improvement practices. They are very sensitive to overgrazing, and recovery rates can be slow. Pond development is limited by the rapid permeability, depth to bedrock, and risk of seepage. Productivity is low because of the shallow depth of the Gosney soils and the very low available water capacity; therefore, careful management and range seeding with drought-tolerant species are needed. Most of this unit is on young lava flows that are characterized by lava blisters, depressions, and rock outcroppings, which restrict irrigation systems and farming operations. The very rapid intake rate, very low available water capacity, and rapid permeability should be considered in irrigation water management.

7. Madras-Agency-Cullius

Moderately deep and shallow, well drained soils that formed in loess over volcaniclastic material of the Deschutes Formation; on lava plains and hills

This map unit is on nearly level to sloping lava plains and hills in Jefferson County. Elevation ranges from 2,000 to 3,200 feet. Slopes range from 0 to 15 percent. The mean annual precipitation is 8 to 12 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 100 to 140 days.

This unit makes up about 8 percent of the survey area. It is about 50 percent Madras soils, 25 percent Agency soils, and 15 percent Cullius soils. The rest is soils of minor extent.

Madras soils are 22 to 40 inches deep to bedrock and are well drained. These soils have a brown sandy loam or loam surface layer and a yellowish brown clay loam subsoil.

Agency soils are 22 to 40 inches deep to bedrock and are well drained. These soils have a grayish brown sandy loam or loam surface layer and a pale brown loam subsoil.

Cullius soils are 10 to 20 inches deep to bedrock and are well drained. These soils have a grayish brown loam surface layer and a grayish brown clay and clay loam subsoil.

Of minor extent in this unit are Bakeoven, Era, Iris, Lickskillet, and Redcliff soils.

This unit is used mainly as irrigated cropland and pasture and for livestock grazing (fig. 1).

Figure 1.—Winter wheat on Madras and Agency soils in an area of general soil map unit 7. The shallow and steeper areas are used for livestock grazing. Mt. Jefferson is in background.

This unit is limited mainly by slope and the hazard of wind erosion. To minimize runoff and erosion, sprinkler irrigation should be used in areas that have slopes of more than 3 percent. In areas that have a sandy loam surface layer, wind erosion is a concern if the soils are left unprotected. Pond development is limited by the depth to bedrock.

8. Holmzie-Searles

Moderately deep, well drained soils that formed in volcanic ash over residuum; on hills

This map unit is on nearly level to sloping hills east of Sisters. Elevation ranges from 2,500 to 4,000 feet. Slopes range from 0 to 30 percent. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 70 to 90 days.

This unit makes up about 2 percent of the survey

area. It is about 40 percent Holmzie soils and 30 percent Searles soils. The rest is soils of minor extent.

Holmzie soils are 20 to 40 inches deep to bedrock and are well drained. They have a dark grayish brown loam surface layer and a reddish brown gravelly clay subsoil.

Searles soils are 20 to 40 inches deep to bedrock and are well drained. They have a grayish brown sandy loam surface layer and yellowish brown very gravelly clay loam subsoil.

Of minor extent in this unit are Buckbert, Lafollette, Redcliff, Redslide, Lickskillet, Deschutes, and Statz soils.

This unit is used mainly for livestock grazing, but the Lower Bridge area west of Terrebonne is used as irrigated cropland.

The main limitation of this unit for range management is the influence of surface ash. The soils are subject to wind erosion if they are left unprotected when applying range improvement practices. The soils are very sensitive to overgrazing, and recovery rates can be slow. Pond development is limited by the depth to bedrock.

9. Caphealy-Reuter

Moderately deep and shallow, well drained soils that formed in colluvium over volcaniclastic material of the Deschutes Formation; on hills

This map unit is on rolling hills east of Madras. Elevation ranges from 2,000 to 3,200 feet. Slopes range from 0 to 30 percent. The mean annual precipitation is 8 to 11 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 110 to 140 days.

The unit makes up about 2 percent of the survey area. It is about 45 percent Caphealy soils and 45 percent Reuter soils. The rest is soils of minor extent.

Caphealy soils are 20 to 40 inches deep to bedrock and are well drained. These soils have a brown sandy loam surface layer and a brown coarse sandy loam and gravelly coarse sand subsoil.

Reuter soils are 10 to 20 inches deep to bedrock and are well drained. These soils have a grayish brown sandy loam surface layer and a brown sandy loam subsoil.

Of minor extent in this unit are Era, Lickskillet, and Redcliff soils.

This unit is used for livestock grazing and irrigated cropland.

The main limitations of this unit are slope, the very low available water capacity, and the hazard of wind erosion. Because of the sandy loam texture of the surface layer, wind erosion is a concern if the soils are left unprotected. The soils are very sensitive to overgrazing, and recovery rates can be slow. Pond development is limited by the depth to bedrock. The very low available water capacity and the shallow depth of the Reuter soil limit the choice of species for range seeding to those that are drought-tolerant. The very low available water capacity and moderately rapid permeability should be considered in irrigation water management. To minimize runoff and erosion, sprinkler irrigation should be used in areas that have slopes of more than 3 percent.

10. Lickskillet-Redcliff-Schrier

Shallow, moderately deep, and very deep, well drained soils that formed in colluvium; on hills

This map unit is on rolling to steep hills north and east of Smith Rock. Elevation ranges from 2,600 to 4,500 feet. Slopes range from 0 to 60 percent. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 70 to 140 days.

This unit makes up about 3 percent of the survey area. It is about 35 percent Lickskillet soils, 30 percent Redcliff soils, and 20 percent Schrier soils. The rest is soils of minor extent.

Lickskillet soils are 12 to 20 inches deep to bedrock and are well drained. They are on south-facing slopes. These soils have a dark grayish brown very gravelly loam surface layer and a brown extremely gravelly loam subsoil.

Redcliff soils are 20 to 40 inches deep to bedrock and are well drained. They are on south-facing slopes. These soils have a brown very gravelly loam surface layer and a dark yellowish brown extremely gravelly clay loam subsoil.

Schrier soils are more than 60 inches deep to bedrock and are well drained. They are on north-facing slopes. These soils have a very dark grayish brown silt loam surface layer, a dark brown silt loam and very gravelly silt loam subsoil, and a dark brown extremely gravelly fine sand substratum.

Of minor extent in this unit are Era, Haystack, and Simas on south-facing slopes and Tub soils on north-facing slopes.

This unit is used for livestock grazing.

Most of this unit is in the Crooked River National Grasslands. The main limitations are slope and aspect. In areas that have slopes of more than 30 percent, range seeding with ground equipment is impractical and livestock distribution is restricted. The south-facing slopes are less suited to grazing during hot periods in

summer. The north-facing slopes have more effective soil moisture in summer for plant growth.

Cool Soils On Lava Plains and Hills

This group consists of four map units. It makes up about 32 percent of the survey area.

11. Dester-Gardone-Borobey

Moderately deep and very deep, excessively drained to well drained soils that formed in ash; in basins on lava plains

This map unit is on lava plains southeast of Bend, from Horse Ridge to Hampton. Elevation ranges from 4,000 to 4,800 feet. Slopes range from 0 to 20 percent. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 43 to 45 degrees F, and the frost free period is 50 to 90 days.

This unit makes up about 11 percent of the survey area. It is about 40 percent Dester soils, 20 percent Gardone soils, and 15 percent Borobey soils. The rest is soils of minor extent.

Dester soils are 20 to 40 inches deep to bedrock and are well drained. They have slopes of 0 to 8 percent. These soils have a grayish brown sandy loam surface layer and a brown clay loam and gravelly clay loam subsoil.

Gardone soils are more than 60 inches deep to bedrock and are excessively drained. They have slopes of 0 to 20 percent. These soils have a dark grayish brown sand surface layer and a light brownish gray loamy sand substratum.

Borobey soils are more than 60 inches deep to bedrock and are somewhat excessively drained. They have slopes of 0 to 5 percent. These soils have a brown sandy loam surface layer and a pale brown sandy loam subsoil. Below this is a pale brown clay loam buried layer.

Of minor extent in this unit are Blayden, Milcan, Ninemile, Stookmoor, Swaler, and Swalesilver soils.

This unit is used for livestock grazing.

The main limitations of this unit are the cool temperatures and the sandy loam to sand texture of the surface layer. The cool soil temperature in spring delays plant growth. Wind erosion is a concern if the soils are left unprotected when applying range improvement practices. The soils are very sensitive to overgrazing, and natural revegetation can be slow. Pond development is limited by the risk of seepage.

12. Beden-Ninemile

Shallow, well drained soils that formed in residuum with ash on the surface; on lava plains

This map unit is on lava plains southeast of Bend, from Horse Ridge to Hampton. Elevation ranges from 4,100 to 5,500 feet. Slopes range from 0 to 10 percent. The mean annual precipitation is 9 to 14 inches, the mean annual air temperature is 43 to 45 degrees F, and the frost-free period is 50 to 90 days.

This unit makes up about 9 percent of the survey area. It is about 55 percent Beden soils and 25 percent Ninemile soils. The rest is soils of minor extent.

Beden soils are 10 to 20 inches deep to bedrock and are well drained. They have a grayish brown stony sandy loam surface layer and a brown loam and clay loam subsoil.

Ninemile soils are 10 to 20 inches deep to bedrock and are well drained. They have a grayish brown sandy loam surface layer and a pale brown clay and gravelly clay subsoil.

Of minor extent in this unit are Embal, Reluctan, Swaler, Swalesilver, and Vergas soils, Xerolls, and Rock outcrop.

This unit is used for livestock grazing.

The main limitations of this unit are the shallow soil depth and cool temperatures. The shallow soil depth and low precipitation limit productivity. The cool soil temperature in spring delays plant growth. The shallow depth to bedrock limits pond development. Wind erosion can be a concern if the soils are left unprotected when applying range improvement practices.

13. Stookmoor-Menbo

Moderately deep, somewhat excessively drained and well drained soils that formed in ash and colluvium; on hills

This map unit is on hills southeast of Bend, from Horse Ridge to Hampton. Elevation ranges from 4,300 to 5,500 feet. Slopes range from 1 to 50 percent. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 43 to 45 degrees F, and the frost-free period is 50 to 90 days.

This unit makes up about 5 percent of the survey area. It is about 40 percent Stookmoor soils and 30 percent Menbo soils. The rest is soils of minor extent.

Stookmoor soils are 20 to 40 inches deep to bedrock and are somewhat excessively drained. They

have a grayish brown loamy sand surface layer and a pale brown sandy loam subsoil.

Menbo soils are 20 to 40 inches deep to bedrock and are well drained. They have a grayish brown stony loam surface layer and a brown very cobbly clay loam subsoil.

Of minor extent in this unit are Beden, Choptie, Ninemile, Redcliff, Reluctan, and Westbutte soils and Rock outcrop.

This unit is used for livestock grazing.

The main limitations are steepness of slope and the cool temperatures. The low precipitation limits productivity. The cool soil temperature in spring delays plant growth. The restricted soil depth and the slope limit pond development. Wind erosion can be a concern if the Stookmoor soils are left unprotected when applying range improvement practices.

14. Wanoga-Fremkle-Rock outcrop

Moderately deep and shallow, well drained soils that formed in ash; on hills

This map unit is on nearly level to steep hills west of Bend and north of Sisters. It is a transition zone from the dry range plant communities to the more moist forested plant communities. Elevation ranges from 2,800 to 4,000 feet. Slopes range from 0 to 50 percent, but most are less than 15 percent. The mean annual precipitation is 12 to 18 inches, the mean annual air temperature is 42 to 47 degrees F, and the frost-free period is 60 to 90 days.

This unit makes up about 7 percent of the survey area. It is about 35 percent Wanoga soils, 25 percent Fremkle soils, and 20 percent Rock outcrop. The rest is soils of minor extent.

Wanoga soils are 20 to 40 inches deep to bedrock and are well drained. They have a dark brown sandy loam surface layer and a dark brown sandy loam subsoil.

Fremkle soils are 10 to 20 inches deep to bedrock and are well drained. They have a dark brown sandy loam surface layer and a dark brown sandy loam subsoil.

Of minor extent in this unit are Bluesters, Fryrear, Henkle, Laidlaw, Omahaling, and Wilt soils.

This unit is used mainly for livestock grazing and timber production.

The main limitations of this unit are the soil depth and cool temperatures. The shallow depth of the Fremkle soil and the areas of Rock outcrop limit productivity. Seeding with ground equipment is impractical in most areas because of the steepness of slope and the areas of Rock outcrop. The cool soil temperature in spring delays plant growth. The restricted soil depth and risk of seepage limit pond development. Wind erosion can be a concern if the soils are left unprotected when applying range improvement practices. Survival of ponderosa pine seedlings is limited because of the low precipitation. Windthrow is a hazard because of the shallow rooting depth and areas of Rock outcrop. The thin organic layer and sandy loam surface layer are susceptible to compaction, displacement, and erosion in the steeper areas.

Soils on Glacial Moraines and Outwash Plains

This group consists of three map units. It makes up about 6 percent of the survey area.

15. Linksterly-Belrick-Douthit

Very deep, well drained, cold soils that formed in ash over glacial till; on glacial moraines

This map unit is on glacial moraines on the foot slopes of the Cascade Mountains, north of Sisters. Elevation ranges from 3,700 to 5,200 feet. Slopes range from 0 to 50 percent. The mean annual precipitation is 50 to 70 inches, the mean annual air temperature is 35 to 44 degrees F, and the frost-free period is 10 to 50 days.

This unit makes up about 3 percent of the survey area. It is about 35 percent Linksterly soils, 25 percent Belrick soils, and 20 percent Douthit soils. The rest is soils of minor extent.

Linksterly soils are more than 60 inches deep to bedrock and are well drained. They have a very dark grayish brown sandy loam surface layer and a substratum that is black and very dark brown loamy fine sand in the upper part and dark reddish brown very cobbly sandy loam in the lower part.

Belrick soils are more than 60 inches deep to bedrock and are well drained. These soils are on north-facing slopes. They have a very dark brown fine sandy loam surface layer and a dark yellowish brown extremely stony sandy loam subsoil.

Douthit soils are more than 60 inches deep to bedrock and are well drained. These soils are on south-facing slopes. They have a very dark grayish brown sandy loam surface layer and a dark brown extremely stony sandy loam subsoil.

Of minor extent in this unit are Bott, Haynap, Kweo, and Minkwell soils.

This unit is used mainly for timber production and wildlife habitat.

The main limitations of this unit are the cold temperatures, slope, and the sandy loam texture of the surface layer. The thin organic layer and sandy loam surface layer are susceptible to compaction, displacement, and erosion in the steeper areas. At elevations of more than about 4,400 feet, severe frost heaving or frost can damage or kill conifer seedlings.

16. Lundgren-Allingham-Circle

Cool soils that are moderately deep and deep to glacial outwash, are well drained, and formed in ash over glacial outwash; on outwash plains

This map unit is on outwash plains in and around Sisters and in the Metolius Basin. Elevation ranges from 2,500 to 4,000 feet. Slopes range from 0 to 30 percent, but most are less than 15 percent. The mean annual precipitation is 12 to 35 inches, the mean annual air temperature is 40 to 47 degrees F, and the frost-free period is 50 to 90 days.

This unit makes up about 2 percent of the survey area. It is about 40 percent Lundgren soils, 15 percent Allingham soils, and 15 percent Circle soils. The rest is soils of minor extent.

Lundgren soils are 20 to 40 inches deep to glacial outwash and are well drained. Slopes are 0 to 3 percent. They have a very dark grayish brown sandy loam surface layer, a brown gravelly sandy loam subsoil, and a dark brown and brown very gravelly loam and extremely gravelly sandy loam substratum.

Allingham soils are 20 to 40 inches deep to glacial outwash and are well drained. Slopes are 0 to 30 percent. They have a dark brown gravelly sandy loam surface layer and a dark brown and dark yellowish brown loam, very gravelly clay loam, and very cobbly clay loam subsoil.

Circle soils are 40 to 60 inches deep to glacial outwash and are well drained. Slopes are 0 to 30 percent. They have a dark brown sandy loam surface layer and a dark brown and dark yellowish brown loam, gravelly loam, and very gravelly clay loam subsoil.

Of minor extent in this unit are Cryaquolls, and Ermabell, Omahaling, Suilotem, Suttle, and Wizard soils.

This unit is used mainly for timber production and wildlife habitat.

The main limitation of this unit is the sandy loam texture of the surface layer. The thin organic layer and sandy loam surface layer are susceptible to compaction, displacement, and erosion in the steeper areas.

17. Tumalo-Plainview

Warm soils that are moderately deep to a duripan or to glacial outwash, are well drained, and formed in ash over glacial outwash; on outwash plains

This map unit is on outwash plains east of Sisters. Elevation ranges from 3,000 to 4,000 feet. Slopes range from 0 to 8 percent. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 47 to 52 degrees F, and the frost-free period is 70 to 100 days.

This unit makes up about 1 percent of the survey area. It is about 50 percent Tumalo soils and 40 percent Plainview soils. The rest is soils of minor extent.

Tumalo soils are 20 to 40 inches deep to a duripan and are well drained. They have a grayish brown sandy loam surface layer and a pale brown very gravelly sandy loam subsoil. Below this is a very pale brown duripan over glacial outwash.

Plainview soils are 20 to 40 inches deep to glacial outwash and more than 60 inches deep to bedrock and are well drained. They have a dark grayish brown sandy loam surface layer, a pale brown and light brownish gray very gravelly sandy loam subsoil, and a pale brown and light brownish gray extremely gravelly sandy loam and very gravelly loamy sand substratum. A duripan is at a depth of 50 to 65 inches.

Of minor extent in this unit are Deschutes and Stukel soils.

This unit is used for irrigated cropland and livestock grazing.

The main limitations of this unit are the sandy loam texture of the surface layer and the risk of seepage. The sandy loam surface layer is susceptible to wind erosion if it is left unprotected. To reduce runoff and erosion, sprinkler irrigation should be used in areas that have slopes of more than 3 percent. These soils are very sensitive to overgrazing, and recovery rates can be slow. Pond development is limited by the risk of seepage.

Soils on Mountains

This group consists of three map units. It makes up about 9 percent of the survey area.

18. Sisters-Yapoah

Very deep, well drained and somewhat excessively drained, cool soils that formed in colluvium that is high

in content of ash or in ash over colluvium and residuum

This map unit is on nearly level to very steep uplands. Elevation ranges from 3,200 to 5,000 feet. Slopes range from 0 to 75 percent. The mean annual precipitation is 18 to 30 inches, the mean annual air temperature is 40 to 47 degrees F, and the frost-free period is 50 to 90 days.

This unit makes up about 1 percent of the survey area. It is about 50 percent Sisters soils and 35 percent Yapoah soils. The rest is soils of minor extent.

Sisters soils are more than 60 inches deep to bedrock and are well drained. They have a dark brown loamy sand surface layer and a dark reddish brown clay loam and loam subsoil.

Yapoah soils are more than 60 inches deep to bedrock and are somewhat excessively drained. They have a dark brown very cobbly loamy sand surface layer and a dark yellowish brown extremely flaggy loamy sand subsoil.

Of minor extent in this unit are Shroyton soils.

This unit is used mainly for timber production and wildlife habitat.

The main limitations of this unit are slope and the loamy sand texture of the surface layer. The thin organic layer and the sandy surface layer are susceptible to compaction, displacement, and erosion in the steeper areas.

19. Smiling-Windego-Parrego

Very deep and moderately deep, well drained, cool soils that formed in ash over colluvium and residuum

This map unit is on the eastern slopes and western scarp of Green Ridge. Elevation ranges from 2,500 to 4,000 feet. Slopes range from 0 to 70 percent. The mean annual precipitation is 15 to 50 inches, the mean annual air temperature is 40 to 47 degrees F, and the frost-free period is 50 to 90 days.

This unit makes up about 6 percent of the survey area. It is about 40 percent Smiling soils, 25 percent Windego soils, and 25 percent Parrego soils. The rest is soils of minor extent.

Smiling soils are more than 60 inches deep to bedrock and are well drained. They have a dark brown sandy loam surface layer and a dark brown loam and clay loam subsoil.

Windego soils are more than 60 inches deep to bedrock and are well drained. They have a dark brown sandy loam surface layer and a dark brown very cobbly clay loam subsoil.

Parrego soils are 20 to 40 inches deep to soft bedrock and are well drained. They have a dark brown sandy loam surface layer and a brown clay loam subsoil.

Of minor extent in this unit are Flarm and Thorn soils.

This unit is used mainly for timber production and wildlife habitat.

The main limitations of this unit are slope and the sandy loam texture of the surface layer. The thin organic layer and sandy loam surface layer are susceptible to compaction, displacement, and erosion in the steeper areas.

20. Gap-Prairie

Deep and moderately deep, well drained, cold soils that formed in ash over colluvium and residuum

This map unit is on the higher eastern slopes of Green Ridge. Elevation ranges from 4,000 to 5,000 feet. Slopes range from 0 to 50 percent. The mean annual precipitation is 25 to 35 inches, the mean annual air temperature is 40 to 44 degrees F, and the frost-free period is 10 to 50 days.

This unit makes up about 2 percent of the survey area. It is about 50 percent Gap soils and 35 percent Prairie soils. The rest is soils of minor extent.

Gap soils are 40 to 60 inches deep to soft bedrock and are well drained. They have a reddish brown sandy loam surface layer and a dark brown gravelly and cobbly loam subsoil.

Prairie soils are 20 to 40 inches deep to soft bedrock and are well drained. They have a dark brown sandy loam surface layer and a dark brown gravelly and cobbly loam subsoil.

Of minor extent in this unit are Bott, Glaze, and Kweo soils.

This unit is used mainly for timber production and wildlife habitat.

The main limitations of this unit are slope, the sandy loam texture of the surface layer, and the cold temperatures. Severe frost heaving or frost can kill or damage conifer seedlings. The thin organic layer and sandy loam surface layer are susceptible to compaction, displacement, and erosion in the steeper areas.

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey 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 inclusions 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, Agency sandy loam, 0 to 3 percent slopes, is a phase of the Agency 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. Allingham-Circle complex, 0 to 15 percent slopes, is an example.

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

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

Major management limitations are those factors that affect the use of the soils for the major uses. The major management limitations may apply to the entire unit or to a given component of the unit.

General management considerations provide additional perspective on the suitability and limitations of the unit for the major uses. They may apply to the entire unit or to a given component of the unit.

1A—Agency sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches

Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 8 inches—grayish brown sandy loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Contrasting Inclusions

- Era soils in swales
- Cullius soils on lava plains
- Caphealy and Reuter soils on adjacent hills
- Soils that have stones on the surface

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, soil depth, permeability, climate

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

2A—Agency loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 8 inches—grayish brown loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Contrasting Inclusions

- Era soils in swales
- Cullius soils on lava plains
- Caphealy and Reuter soils on adjacent hills
- Soils that have stones on the surface
- Soils that have a silt loam surface layer

Major Uses

Irrigated cropland (fig. 2), livestock grazing

Figure 2.—Onions in an area of Agency loam, 0 to 3 percent slopes. Mt. Jefferson in the Cascade Range in background.

Major Management Limitations

Soil depth, permeability, climate

General Management Considerations

Irrigated cropland

- This soil is well suited to irrigated crops.

Livestock grazing

- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

2B—Agency loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 8 inches—grayish brown loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Contrasting Inclusions

- Era soils in swales
- Caphealy and Reuter soils on adjacent hills
- Soils that have stones on the surface
- Soils that have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Slope, soil depth, permeability, climate

General Management Considerations

Irrigated cropland

- Because of the steepness of slope, sprinkler irrigation systems should be used to reduce runoff and erosion.

Livestock grazing

- Pond development is limited by the soil depth and risk of seepage.

• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

2C—Agency loam, 8 to 15 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 8 inches—grayish brown loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Contrasting Inclusions

• Era soils in swales
• Caphealy and Reuter soils on adjacent hills
• Soils that have stones on the surface
• Soils that have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Slope, soil depth, permeability, climate

General Management Considerations

Irrigated cropland

• Because of the steepness of slope, sprinkler irrigation systems should be used to reduce runoff and erosion.

Livestock grazing

• Pond development is limited by the soil depth, steepness of slope, and risk of seepage.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

3B—Agency-Madras complex, 0 to 8 percent slopes

Composition

Agency soil and similar inclusions—45 percent
Madras soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Loess over semiconsolidated sediment
Elevation: 2,700 to 3,200 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—110 to 130 days

Typical Profile of the Agency Soil

0 to 8 inches—grayish brown loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Agency Soil

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Typical Profile of the Madras Soil

0 to 10 inches—brown loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Properties and Qualities of the Madras Soil

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Bakeoven soils in intermound areas
- Deep, silty soils on mounds

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability

General Management Considerations

- Pond development is limited by the soil depth and risk of seepage.

Range Site

Loamy 10-12pz

3C—Agency-Madras complex, 8 to 15 percent slopes

Composition

Agency soil and similar inclusions—45 percent
Madras soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Loess over semiconsolidated sediment
Elevation: 2,700 to 3,200 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—110 to 130 days

Typical Profile of the Agency Soil

0 to 8 inches—grayish brown loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Agency Soil

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Typical Profile of the Madras Soil

0 to 10 inches—brown loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Properties and Qualities of the Madras Soil

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Bakeoven soils in intermound areas
- Deep, silty soils on mounds

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, slope

General Management Considerations

- Pond development is limited by the soil depth, steepness of slope, and risk of seepage.

Range Site

Loamy 10-12pz

4C—Allingham-Circle complex, 0 to 15 percent slopes

Composition

Allingham soil and similar inclusions—50 percent
Circle soil and similar inclusions—50 percent

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 35 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Allingham Soil

1 inch to 0—organic mat
0 to 16 inches—very dark grayish brown and dark brown gravelly sandy loam
16 to 28 inches—dark brown loam
28 to 65 inches—dark yellowish brown very gravelly and very cobbly clay loam

Properties and Qualities of the Allingham Soil

Depth: Glacial outwash at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Typical Profile of the Circle Soil

1 inch to 0—organic mat
0 to 16 inches—dark brown sandy loam
16 to 42 inches—dark brown and dark yellowish brown loam and gravelly loam
42 to 65 inches—dark yellowish brown very gravelly clay loam

Properties and Qualities of the Circle Soil

Depth: Glacial outwash at a depth of 40 to 50 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 9 inches

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

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4D—Allingham-Circle complex, 15 to 30 percent slopes

Composition

Allingham soil and similar inclusions—50 percent
Circle soil and similar inclusions—50 percent

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 35 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Allingham Soil

1 inch to 0—organic mat
0 to 16 inches—very dark grayish brown and dark brown gravelly sandy loam
16 to 28 inches—dark brown loam
28 to 65 inches—dark yellowish brown very gravelly and very cobbly clay loam

Properties and Qualities of the Allingham Soil

Depth: Glacial outwash at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Typical Profile of the Circle Soil

1 inch to 0—organic mat
0 to 16 inches—dark brown sandy loam
16 to 42 inches—dark brown and dark yellowish brown loam and gravelly loam
42 to 65 inches—dark yellowish brown very gravelly clay loam

Properties and Qualities of the Circle Soil

Depth: Glacial outwash at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 9 inches

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-17

5A—Aquolls, 0 to 1 percent slopes

Composition

Aquolls—95 percent
Contrasting inclusions—5 percent

Setting

Landform: Closed basins
Slope: 0 to 1 percent
Parent material: Lacustrine sediment
Elevation: 2,800 to 2,900 feet
Native plants: Quaking aspen, willow, sedges
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Representative Profile

0 to 3 inches—black loam
3 to 11 inches—black silt loam
11 to 20 inches—very dark gray, mottled silt loam
20 to 60 inches—dark grayish brown, mottled silty clay

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Poorly drained
Depth to water table: 6 to 12 inches below the surface in April through June
Permeability: Slow
Available water capacity: About 12 inches

Contrasting Inclusions

- Deep, moderately well drained soils along the margins of basins

Major Use

Livestock grazing

Major Management Limitations

High water table, climate

General Management Considerations

- If seeding is needed, select plants that tolerate seasonal wetness.
- Grazing during wet periods can cause soil compaction and displacement and damage plants.
- The cold climate and soil temperature delay the growth of forage and shorten the growing season.

Range Site

Wet Meadow

6A—Bakeoven very cobbly loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Residuum
Elevation: 2,000 to 3,200 feet
Native plants: Stiff sagebrush, Sandberg bluegrass, bluebunch wheatgrass, bottlebrush squirreltail
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 2 inches—brown very cobbly loam

2 to 6 inches—brown very gravelly loam
6 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Soils that are moderately deep to bedrock
- Areas of exposed bedrock

Major Use

Livestock grazing

Major Management Limitations

Soil depth, rock fragments in surface layer, available water capacity

General Management Considerations

- Pond development is limited by the soil depth.
- The low available water capacity and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.

Range Site

Very Shallow Loam 10-14pz

7A—Bakeoven-Agency-Madras complex, 0 to 3 percent slopes

Composition

Bakeoven soil and similar inclusions—30 percent
Agency soil and similar inclusions—30 percent
Madras soil and similar inclusions—30 percent
Contrasting inclusions—10 percent

Setting

Landscape position: Bakeoven soil—intermounds; Agency and Madras soils—mounds
Landform: Lava plains
Parent material: Bakeoven soil—residuum; Agency and Madras soils—loess over semiconsolidated sediment
Elevation: 2,000 to 3,000 feet
Native plants: Bakeoven soil—stiff sagebrush, Sandberg bluegrass, bluebunch wheatgrass, bottlebrush squirreltail; Agency and Madras soils—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—110 to 130 days

Typical Profile of the Bakeoven Soil

0 to 2 inches—brown very cobbly loam
2 to 6 inches—brown very gravelly loam
6 inches—basalt

Properties and Qualities of the Bakeoven Soil

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

Typical Profile of the Agency Soil

0 to 8 inches—grayish brown loam
8 to 24 inches—brown loam
24 to 29 inches—pale brown cobbly loam
29 to 33 inches—weathered tuff
33 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Agency Soil

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Typical Profile of the Madras Soil

0 to 10 inches—brown loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Properties and Qualities of the Madras Soil

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Deep, silty soils on mounds

Major Use

Livestock grazing

Major Management Limitations

Bakeoven soil—soil depth, rock fragments in surface layer, available water capacity
Agency and Madras soils—soil depth

General Management Considerations

- Pond development is limited by the soil depth.
- The low available water capacity and restricted depth of the Bakeoven soil limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface of the Bakeoven soil.

Range Site

Bakeoven soil—Very Shallow Loam 10-14pz
Agency and Madras soils—Loamy 10-12pz

8B—Beden sandy loam, dry, 1 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over residuum derived from basalt or welded tuff
Elevation: 4,100 to 4,800 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 11 inches—grayish brown and brown sandy loam
11 to 15 inches—brown loam
15 to 18 inches—brown clay loam
18 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Reluctan and Ninemile soils on lava plains
- Embal soils in drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, surface texture

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because this soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Range Site

Shallow Pumice 9-11pz

9C—Beden sandy loam, moist, 3 to 15 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over residuum derived from basalt or welded tuff
Elevation: 4,100 to 4,800 feet
Native plants: Western juniper, mountain big sagebrush, Idaho fescue, Thurber needlegrass
Climatic factors:
Mean annual precipitation—9 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 11 inches—grayish brown and brown sandy loam
11 to 15 inches—brown loam
15 to 18 inches—brown clay loam
18 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Stookmoor soils on ridgetops
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because this soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Shallow Pumice Hills 9-11pz

10E—Beden sandy loam, 30 to 50 percent north slopes

Composition

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

Setting

Landscape position: North-facing slopes
Landform: Hills
Parent material: Ash over residuum derived from basalt or welded tuff
Elevation: 4,200 to 5,000 feet
Native plants: Mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 11 inches—grayish brown and brown sandy loam
11 to 15 inches—brown loam
15 to 18 inches—brown clay loam
18 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Ninemile soils on lava plains
- Westbutte soils on hillsides
- Rock outcrop on knolls

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, surface texture, slope

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because this soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the steepness of slope and soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and makes range seeding with ground equipment impractical.

Range Site

North Slopes 10-12pz

11B—Beden stony sandy loam, 0 to 10 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over residuum derived from basalt

or welded tuff
Elevation: 4,100 to 4,800 feet
Native plants: Western juniper, low sagebrush, Idaho fescue, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 11 inches—grayish brown and brown stony sandy loam
11 to 15 inches—brown loam
15 to 18 inches—brown clay loam
18 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Ninemile soils on lava plains
- Embal soils in drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, surface texture, rock fragments in surface layer

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because this soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.

Range Site

Juniper Lava Benches 9-12pz

12B—Beden-Ninemile complex, 0 to 10 percent slopes

Composition

Beden soil and similar inclusions—45 percent
Ninemile soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash over residuum
Elevation: 4,200 to 4,800 feet
Native plants: Beden soil—western juniper, low sagebrush, Idaho fescue, Sandberg bluegrass; Ninemile soil—low sagebrush, Idaho fescue, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Beden Soil

0 to 11 inches—grayish brown and brown stony sandy loam
11 to 15 inches—brown loam
15 to 18 inches—brown clay loam
18 inches—basalt

Properties and Qualities of the Beden Soil

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

Typical Profile of the Ninemile Soil

0 to 7 inches—grayish brown sandy loam
7 to 19 inches—pale brown clay and gravelly clay
19 inches—basalt

Properties and Qualities of the Ninemile Soil

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

Contrasting Inclusions

- Very shallow soils that have a very stony surface layer and are along bedrock escarpments
- Embal and Dester soils in drainageways

- Choptie soils on hills
- Reluctan soils on lava plains

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, surface texture, rock fragments in surface layer

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soils in this unit are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.

Range Site

Beden soil—Juniper Lava Benches 9-12pz
Ninemile soil—Pumice Claypan 9-11pz

13C—Belrick fine sandy loam, 0 to 15 percent slopes

Composition

Belrick soil and similar inclusions—95 percent
Contrasting inclusions—5 percent

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, white fir, snowbrush, chinkapin, pinegrass
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 16 inches—very dark brown fine sandy loam
16 to 24 inches—very dark brown and black loamy fine sand and fine sand
24 to 65 inches—dark yellowish brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 6 inches

Contrasting Inclusions

- Douthit soils on side slopes
- Soils that have glacial till at a depth of 40 inches or more
- Soils that flood in spring and are adjacent to creeks

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical or chemical treatment or by livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.

Forest Service Plant Association

CW-C2-12

13D—Belrick fine sandy loam, 15 to 30 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, white fir, snowbrush, chinkapin, pinegrass
Climatic factors:

Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 16 inches—very dark brown fine sandy loam
16 to 24 inches—very dark brown and black loamy fine sand and fine sand
24 to 65 inches—dark yellowish brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 6 inches

Contrasting Inclusions

- Douthit soils on side slopes
- Linksterly soils on side slopes
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical or chemical treatment or by livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.

Forest Service Plant Association

CW-C2-12

14C—Belrick fine sandy loam, cool, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 4,400 to 5,200 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—60 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 30 days

Typical Profile

1 inch to 0—organic mat
0 to 16 inches—very dark brown fine sandy loam
16 to 24 inches—very dark brown and black loamy fine sand and fine sand
24 to 65 inches—dark yellowish brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 6 inches

Contrasting Inclusions

- Douthit soils on side slopes and ridges
- Linksterly soils on side slopes

Major Use

Woodland

Major Management Limitations

Frost heaving, low fertility, susceptibility to compaction

General Management Considerations

- Severe frost or frost heaving can damage or kill seedlings.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical or chemical treatment or by livestock grazing.

• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.

Forest Service Plant Association

CD-S6-13

15C—Belrick fine sandy loam, dry, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,000 feet
Native plants: Ponderosa pine, sedges, Idaho fescue, peavine
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 16 inches—very dark brown fine sandy loam
16 to 24 inches—very dark brown and black loamy fine sand and fine sand
24 to 65 inches—dark yellowish brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 6 inches

Contrasting Inclusions

• Douthit soils on side slopes
• Linksterly soils on side slopes

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical or chemical treatment or by livestock grazing.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.

Forest Service Plant Association

CP-G2-12

16E—Belrick-Douthit complex, 30 to 50 percent slopes

Composition

Belrick soil and similar inclusions—45 percent
Douthit soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Belrick soil—north-facing slopes; Douthit soil—south-facing slopes
Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 5,200 feet
Native plants: Belrick soil—ponderosa pine, white fir, snowbrush, chinkapin, pinegrass; Douthit soil—ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile of the Belrick Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown fine sandy loam
16 to 24 inches—very dark brown and black loamy fine sand and fine sand
24 to 65 inches—dark yellowish brown extremely stony sandy loam

Properties and Qualities of the Belrick Soil

Depth: Glacial till at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 6 inches

Typical Profile of the Douthit Soil

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Properties and Qualities of the Douthit Soil

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Linksterly soils on side slopes
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Machinery should be used only in areas covered with logging slash or brush to reduce soil displacement.
- Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.

Forest Service Plant Association

Belrick soil—CW-C2-12
Douthit soil—CD-S6-13

17A—Blayden loamy sand, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Old alluvium derived from basalt with ash on the surface
Elevation: 4,100 to 4,800 feet
Native plants: Wyoming big sagebrush, Idaho fescue, western needlegrass, Thurber needlegrass, Indian ricegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 3 inches—grayish brown loamy sand
3 to 15 inches—brown and pale brown gravelly loam
15 to 60 inches—indurated duripan

Soil Properties and Qualities

Depth: Duripan at a depth of 12 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate above the duripan
Available water capacity: About 3 inches

Contrasting Inclusions

- Menbo soils on toe slopes of hills
- Stookmoor soils along adjacent lava plains
- Borobey and Gardone soils in drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth.
• The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Range Site

Gravelly Terrace 9-11pz

18D—Bluesters gravelly sandy loam, 15 to 50 percent slopes

Composition

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

Setting

Landform: North- and south-facing slopes of cinder cones
Parent material: Ash over cinders
Elevation: 3,000 to 5,500 feet
Native plants: Western juniper, ponderosa pine, mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

0 to 16 inches—dark brown gravelly sandy loam
16 to 60 inches—black and reddish brown cinders

Soil Properties and Qualities

Depth: Cinders at a depth of 14 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 2 inches

Contrasting Inclusions

• Fryrear soils on side slopes
• Rock outcrop

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, permeability, slope, aspect, rooting depth, low fertility, susceptibility to compaction

General Management Considerations

Livestock grazing

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Pond development is limited by the risk of seepage and steepness of slope.
• The steepness of slope restricts the distribution of livestock and limits range seeding with ground equipment.
• The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Woodland

• The seedling survival rate is poor because of the low precipitation and low available water capacity.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Juniper-Pine-Fescue

19A—Borobey sandy loam, 0 to 5 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over old alluvium
Elevation: 4,200 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 21 inches—grayish brown and brown sandy loam
21 to 51 inches—pale brown sandy loam
51 to 60 inches—pale brown clay loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately slow
Available water capacity: About 5 inches

Contrasting Inclusions

- Reluctan soils on higher toe slopes
- Ninemile soils on lava plains
- Stookmoor soils along adjacent lava plains
- Gardone and Dester soils in drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice 8-10pz

20A—Borobey gravelly sandy loam, hardpan substratum, 0 to 5 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over old alluvium
Elevation: 4,200 to 4,800 feet
Native plants: Mountain big sagebrush, western needlegrass, Ross sedge, bottlebrush squirreltail
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 8 inches—grayish brown gravelly sandy loam
8 to 24 inches—pale brown loamy sand
24 to 45 inches—pale brown sandy loam
45 to 60 inches—indurated duripan

Soil Properties and Qualities

Depth: Duripan at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately slow above the duripan
Available water capacity: About 4 inches

Contrasting Inclusions

- Ninemile soils on lava plains
- Stookmoor soils along adjacent lava plains
- Gardone and Dester soils in drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice Flat 9-11pz

21C—Bott-Douthit complex, 0 to 15 percent slopes

Composition

Bott soil and similar inclusions—60 percent
Douthit soil and similar inclusions—30 percent
Contrasting inclusions—10 percent

Setting

Landform: Bott soil—mountains; Douthit soil—moraines
Parent material: Bott soil—ash over colluvium; Douthit soil—ash over glacial till
Elevation: 3,700 to 5,000 feet
Native plants: Bott soil—ponderosa pine, Douglas fir, snowbrush, chinkapin, brackenfern; Douthit soil—ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 50 days

Typical Profile of the Bott Soil

1 inch to 0—organic mat
0 to 10 inches—dark yellowish brown gravelly sandy loam
10 to 23 inches—dark yellowish brown sandy loam
23 to 62 inches—dark brown very stony loam

Properties and Qualities of the Bott Soil

Depth: Colluvium at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Typical Profile of the Douthit Soil

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Properties and Qualities of the Douthit Soil

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 5 inches

Contrasting Inclusions

• Soils that have bedrock at a depth of 20 to 40 inches
• Minkwell soils on side slopes and toe slopes
• Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Bott soil—CW-C2-11
Douthit soil—CD-S6-13

21D—Bott-Douthit complex, 15 to 30 percent slopes

Composition

Bott soil and similar inclusions—60 percent
Douthit soil and similar inclusions—30 percent
Contrasting inclusions—10 percent

Setting

Landform: Bott soil—mountains; Douthit soil—moraines
Parent material: Bott soil—ash over colluvium; Douthit soil—ash over glacial till
Elevation: 3,700 to 5,000 feet
Native plants: Bott soil—ponderosa pine, Douglas fir, snowbrush, chinkapin, brackenfern; Douthit soil—ponderosa pine, Douglas fir, common snowberry, forbs

Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 50 days

Typical Profile of the Bott Soil

1 inch to 0—organic mat
0 to 10 inches—dark yellowish brown gravelly sandy loam
10 to 23 inches—dark yellowish brown sandy loam
23 to 62 inches—dark brown very stony loam

Properties and Qualities of the Bott Soil

Depth: Colluvium at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Typical Profile of the Douthit Soil

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Properties and Qualities of the Douthit Soil

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Minkwell soils on side slopes and toe slopes
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Bott soil—CW-C2-11
Douthit soil—CD-S6-13

22E—Bott-Kweo complex, 30 to 50 percent slopes

Composition

Bott soil and similar inclusions—55 percent
Kweo soil and similar inclusions—35 percent
Contrasting inclusions—10 percent

Setting

Landform: Bott soil—mountains; Kweo soil—cinder cones
Parent material: Bott soil—ash over colluvium; Kweo soil—ash over cinders
Elevation: 3,700 to 5,000 feet
Native plants: Bott soil—ponderosa pine, Douglas fir, snowbrush, chinkapin, brackenfern; Kweo soil—ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile of the Bott Soil

1 inch to 0—organic mat
0 to 10 inches—dark yellowish brown gravelly sandy loam
10 to 23 inches—dark yellowish brown sandy loam
23 to 62 inches—dark brown very stony loam

Properties and Qualities of the Bott Soil

Depth: Colluvium at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained

Permeability: Moderate
Available water capacity: About 8 inches

Typical Profile of the Kweo Soil

1 inch to 0—organic mat
0 to 13 inches—dark brown gravelly sandy loam
13 to 25 inches—dark reddish brown very gravelly sandy loam
25 to 60 inches—dark yellowish brown cinders

Properties and Qualities of the Kweo Soil

Depth: Cinders at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 40 to 60 inches
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Bott and Kweo soils—slope, low fertility, susceptibility to compaction
Kweo soil—rooting depth, rock fragments in surface layer

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because the coarse-textured Kweo soil has insufficient anchoring capability, trees on this soil are subject to windthrow.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- To minimize soil displacement, machinery should be used only in areas covered with logging slash or brush.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Bott soil—CW-C2-11
Kweo soil—CD-S6-13

23A—Buckbert sandy loam, 0 to 3 percent slopes

Composition

Buckbert soil and similar inclusions—95 percent
Contrasting inclusions—5 percent

Setting

Landform: Hills
Parent material: Ash over alluvium
Elevation: 2,500 to 2,800 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 21 inches—brown sandy loam
21 to 52 inches—pale brown loam
52 to 60 inches—yellowish brown sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 9 inches

Contrasting Inclusions

- Redmond soils on side slopes

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

24A—Caphealy-Reuter complex, 0 to 3 percent slopes

Composition

Caphealy soil and similar inclusions—45 percent
Reuter soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Colluvium over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Caphealy soil—western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue; Reuter soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Caphealy Soil

0 to 16 inches—grayish brown and brown sandy loam
16 to 19 inches—brown coarse sandy loam
19 to 23 inches—brown gravelly coarse sand
23 to 26 inches—weathered, fractured tuff
26 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Caphealy Soil

Depth: Soft bedrock at a depth of 20 to 38 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Reuter Soil

0 to 12 inches—brown sandy loam
12 to 24 inches—weathered, fractured tuff
24 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Reuter Soil

Depth: Soft bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 1 inch

Contrasting Inclusions

- Lickskillet soils on hills
- Era soils in swales

Major Uses

Livestock grazing, irrigated cropland

Major Management Limitations

Surface texture, soil depth, available water capacity

General Management Considerations

Livestock grazing

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- The low available water capacity of the soils and the restricted depth of the Reuter soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Irrigated cropland

- Because the surface layer is sandy loam, these soils are subject to wind erosion if left unprotected.
- Because of the low available water capacity of these soils, intensive irrigation water management is needed.

Range Site

Caphealy soil—Droughty Loam 8-10pz
Reuter soil—Droughty 8-12pz

24B—Caphealy-Reuter complex, 3 to 8 percent slopes

Composition

Caphealy soil and similar inclusions—45 percent
Reuter soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Colluvium over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet

Native plants: Caphealy soil—western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue; Reuter soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Caphealy Soil

0 to 16 inches—grayish brown and brown sandy loam
16 to 19 inches—brown coarse sandy loam
19 to 23 inches—brown gravelly coarse sand
23 to 26 inches—weathered, fractured tuff
26 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Caphealy Soil

Depth: Soft bedrock at a depth of 20 to 38 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Reuter Soil

0 to 12 inches—brown sandy loam
12 to 24 inches—weathered, fractured tuff
24 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Reuter Soil

Depth: Soft bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 1 inch

Contrasting Inclusions

- Lickskillet soils on hills
- Era soils in swales

Major Uses

Livestock grazing, irrigated cropland

Major Management Limitations

Surface texture, soil depth, available water capacity, slope

General Management Considerations

Livestock grazing

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- The low available water capacity of the soils and the restricted depth of the Reuter soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Irrigated cropland

- Because the surface layer is sandy loam, these soils are subject to wind erosion if left unprotected.
- Because of the low available water capacity of these soils, intensive irrigation water management is needed.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Range Site

Caphealy soil—Droughty Loam 8-10pz
Reuter soil—Droughty 8-12pz

24C—Caphealy-Reuter complex, 8 to 15 percent slopes

Composition

Caphealy soil and similar inclusions—45 percent
Reuter soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Colluvium over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Caphealy soil—western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue; Reuter soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Caphealy Soil

0 to 16 inches—grayish brown and brown sandy loam
16 to 19 inches—brown coarse sandy loam
19 to 23 inches—brown gravelly coarse sand
23 to 26 inches—weathered, fractured tuff
26 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Caphealy Soil

Depth: Soft bedrock at a depth of 20 to 38 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Reuter Soil

0 to 12 inches—brown sandy loam

12 to 24 inches—weathered, fractured tuff
24 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Reuter Soil

Depth: Soft bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 1 inch

Contrasting Inclusions

- Lickskillet soils on hills
- Era soils in swales

Major Uses

Livestock grazing, irrigated cropland

Major Management Limitations

Surface texture, soil depth, available water capacity, slope

General Management Considerations

Livestock grazing

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- The low available water capacity of the soils and the restricted depth of the Reuter soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- Pond development is limited by the steepness of slope.

Irrigated cropland

- Because the surface layer is sandy loam, these soils are subject to wind erosion if left unprotected.
- Intensive irrigation water management is needed because of the low available water capacity.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Range Site

Caphealy soil—Droughty Loam 8-10pz
Reuter soil—Droughty 8-12pz

24D—Caphealy-Reuter complex, 15 to 30 percent slopes

Composition

Caphealy soil and similar inclusions—45 percent
Reuter soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Colluvium over semiconsolidated sediment
Elevation: 2,000 to 3,200 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Caphealy Soil

0 to 16 inches—grayish brown and brown sandy loam
16 to 19 inches—brown coarse sandy loam
19 to 23 inches—brown gravelly coarse sand
23 to 26 inches—weathered, fractured tuff
26 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Caphealy Soil

Depth: Soft bedrock at a depth of 20 to 38 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Reuter Soil

0 to 12 inches—brown sandy loam
12 to 24 inches—weathered, fractured tuff
24 inches—welded tuff of the Deschutes Formation

Properties and Qualities of the Reuter Soil

Depth: Soft bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 1 inch

Contrasting Inclusions

- Lickskillet soils on hills
- Era soils in swales

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, available water capacity, slope

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.

• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• The low available water capacity of the soils and the restricted depth of the Reuter soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• Pond development is limited by the steepness of slope.

Range Site

South 9-12pz

25C—Choptie-Westbutte complex, 5 to 20 percent slopes

Composition

Choptie soil and similar inclusions—50 percent
Westbutte soil and similar inclusions—40 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Residuum and colluvium derived from basalt or welded tuff with ash on the surface
Elevation: 4,000 to 5,500 feet
Native plants: Antelope bitterbrush, mountain big sagebrush, common snowberry, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 14 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Choptie Soil

0 to 15 inches—grayish brown and brown loam
15 to 19 inches—brown gravelly loam
19 inches—welded tuff

Properties and Qualities of the Choptie Soil

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

Typical Profile of the Westbutte Soil

0 to 9 inches—very dark grayish brown stony loam
9 to 21 inches—dark brown very cobbly loam
21 to 30 inches—brown very cobbly clay loam
30 inches—welded tuff

Properties and Qualities of the Westbutte Soil

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

Contrasting Inclusions

• Very shallow soils
• Rock outcrop on knolls

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, rock fragments in surface layer, slope

General Management Considerations

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Pond development is limited by the soil depth and steepness of slope.
• Shallow rooting depth of the Choptie soil limits the choice of species for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is limited by the rock fragments on the surface.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Shrubby Mountain Clayey 12-16pz

26A—Clinefalls sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Stream terraces
Parent material: Ash over alluvium
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches

Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 15 inches—dark grayish brown and grayish brown sandy loam
15 to 20 inches—grayish brown gravelly sandy loam
20 to 25 inches—brown very gravelly loamy sand
25 to 60 inches—dark gray, stratified extremely gravelly sand and sand

Soil Properties and Qualities

Depth: Stratified sand and gravel at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Deschutes soils in swales
- Lafollette soils on terraces
- Poorly drained soils along drainageways

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the very rapid permeability of the substratum.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

27A—Clovkamp loamy sand, 0 to 3 percent slopes

Composition

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

Setting

Landform: Old stream terraces on lava plains
Parent material: Ash over alluvium
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 12 inches—grayish brown and brown loamy sand
12 to 24 inches—brown loamy sand
24 to 40 inches—pale brown gravelly loamy fine sand
40 to 60 inches—pale brown extremely gravelly sand

Soil Properties and Qualities

Depth: Extremely gravelly layer at a depth of 35 to 50 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 5 inches

Contrasting Inclusions

- Deskamp soils on side slopes

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is loamy sand, this soil is subject to wind erosion if left unprotected.
- Because of the surface texture, the water infiltration

rate is high, which limits the type of irrigation system that can be used.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

28A—Clovkamp loamy sand, bedrock substratum, 0 to 3 percent slopes

Composition

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

Setting

Landform: Old stream terraces on lava plains
Parent material: Ash over alluvium
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 12 inches—grayish brown and brown loamy sand
12 to 24 inches—brown loamy sand
24 to 40 inches—pale brown gravelly loamy fine sand
40 to 50 inches—pale brown extremely gravelly sand
50 inches—basalt

Soil Properties and Qualities

Depth: Extremely gravelly layer at a depth of 35 to 50 inches; bedrock at a depth of 40 to 60 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 4 inches

Contrasting Inclusions

- Deskamp soils on side slopes

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is loamy sand, this soil is subject to wind erosion if left unprotected.
- Because of the surface texture, the water infiltration rate is high, which limits the type of irrigation system that can be used.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

29A—Cryaquolls, 0 to 3 percent slopes

Composition

Cryaquolls and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landform: Pumice-mantled flood plains
Parent material: Mixed alluvium
Elevation: 3,000 to 4,500 feet
Native plants: Willow, birch, sedges, rushes
Climatic factors:
Mean annual precipitation—15 to 35 inches
Mean annual air temperature—40 to 45 degrees F
Frost-free period—10 to 50 days

Representative Profile

1 inch to 0—organic mat
0 to 2 inches—dark brown silt loam
2 to 14 inches—very dark gray loam
14 to 18 inches—very dark gray sandy loam
18 to 60 inches—very dark gray loamy sand and sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Very poorly drained and poorly drained
Depth to water table: At the surface to a depth of 24 inches below the surface in November through August
Permeability: Moderate over rapid

Available water capacity: About 7 inches
Flooding: Rare

Contrasting Inclusions

• Soils that are somewhat poorly drained and moderately well drained

Major Uses

Livestock grazing, riparian habitat (fig. 3)

Figure 3.—Riparian habitat in an area of Cryaquolls, 0 to 3 percent slopes. This area is used for grazing.

Major Management Limitations

High water table, climate

General Management Considerations

Livestock grazing

• If seeding is needed, select plants that tolerate seasonal wetness.
• Grazing during wet periods can cause soil compaction and displacement and damage plants.
• The cold climate and soil temperature delay the growth of forage and shorten the growing season.

Range Site

Cold Wet Meadow

30A—Cullius loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over colluvium and semiconsolidated sediment
Elevation: 2,500 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 6 inches—grayish brown loam
6 to 9 inches—grayish brown clay loam
9 to 17 inches—grayish brown clay
17 to 18 inches—weathered, fractured tuff
18 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 2.5 inches

Contrasting Inclusions

• Era soils in swales
• Madras soils on lava plains
• Soils that are similar to this Cullius soil but are 20 to 40 inches deep to bedrock
• Soils that are similar to this Cullius soil but have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, permeability, climate, available water capacity

General Management Considerations

Irrigated cropland

• Because this soil is shallow, intensive irrigation water management is needed for crop production.
• Because water-soluble chemicals can be carried in the runoff, care should be taken to prevent excessive irrigation rates that result in overland flow.

Livestock grazing

• Pond development is limited by the soil depth.
• The low annual precipitation, low available water capacity, and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

30B—Cullius loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over colluvium and semiconsolidated sediment
Elevation: 2,500 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 6 inches—grayish brown loam
6 to 9 inches—grayish brown clay loam
9 to 17 inches—grayish brown clay
17 to 18 inches—weathered, fractured tuff
18 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 2.5 inches

Contrasting Inclusions

- Era soils in swales
- Madras soils on lava plains
- Soils that are similar to this Cullius soil but are 20 to 40 inches deep to bedrock
- Soils that are similar to this Cullius soil but have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, permeability, slope, climate, available water capacity

General Management Considerations

Irrigated cropland

- Because this soil is shallow, intensive irrigation water management is needed for crop production.
- Because water-soluble chemicals can be carried in the runoff, care should be taken to prevent excessive irrigation rates that result in overland flow.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Pond development is limited by the soil depth.
- The low annual precipitation, low available water capacity, and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

30C—Cullius loam, 8 to 15 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over colluvium and semiconsolidated sediment
Elevation: 2,500 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 6 inches—grayish brown loam
6 to 9 inches—grayish brown clay loam
9 to 17 inches—grayish brown clay
17 to 18 inches—weathered, fractured tuff
18 inches—welded tuff of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained

Permeability: Slow
Available water capacity: About 2.5 inches

Contrasting Inclusions

- Era soils in swales
- Madras soils on lava plains
- Soils that are similar to this Cullius soil but are 20 to 40 inches deep to bedrock
- Soils that are similar to this Cullius soil but have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, permeability, slope, climate, available water capacity

General Management Considerations

Irrigated cropland

- Because this soil is shallow, intensive irrigation water management is needed for crop production.
- Because water-soluble chemicals can be carried in the runoff, care should be taken to prevent excessive irrigation rates that result in overland flow.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Pond development is limited by the soil depth and steepness of slope.
- The low annual precipitation, low available water capacity, and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

31A—Deschutes sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Soils that have a loamy sand or gravelly sandy loam surface layer
- Redmond soils in swales
- Stukel soils on ridges
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

31B—Deschutes sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Soils that have a loamy sand or gravelly sandy loam surface layer
- Redmond soils in swales
- Stukel soils on ridges
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability, slope

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

32A—Deschutes sandy loam, dry, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Soils that have a loamy sand or gravelly sandy loam surface layer

- Redmond soils in swales
- Stukel soils on ridges
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing (fig. 4)

Figure 4.—Irrigated pasture and rangeland in an area of Deschutes sandy loam, dry, 0 to 3 percent slopes, in foreground. Lickskillet and Redcliff soils in background.

Major Management Limitations

Soil depth, surface texture, climate

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 8-10pz

33B—Deschutes-Houstake complex, 0 to 8 percent slopes

Composition

Deschutes soil and similar inclusions—50 percent
Houstake soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Typical Profile of the Houstake Soil

0 to 5 inches—brown sandy loam
5 to 22 inches—brown sandy loam
22 to 60 inches—light brownish gray and brown sandy loam

Properties and Qualities of the Houstake Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 7 inches

Contrasting Inclusions

- Redmond soils in swales
- Soils that have a loamy sand surface layer
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Deschutes and Houstake soils—surface texture, permeability, slope, climate
Deschutes soil—soil depth

General Management Considerations

Irrigated cropland

- On the Deschutes soil, well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, the soils in this unit are subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.
- Because of the steepness of slope and undulating topography, sprinkler irrigation systems are best suited to this unit.

Livestock grazing

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 8-10pz

34C—Deschutes-Stukel complex, 0 to 15 percent slopes

Composition

Deschutes soil and similar inclusions—50 percent
Stukel soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Deschutes soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread; Stukel soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Typical Profile of the Stukel Soil

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Properties and Qualities of the Stukel Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Redmond soils in swales
- Soils that have a loamy sand surface layer
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability, slope

General Management Considerations

Irrigated cropland

- Because the Stukel soil is shallow, intensive irrigation water management is needed for crop production.
- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, these soils are subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.
- Because of the steepness of slope and undulating topography, sprinkler irrigation systems are best suited to this unit.

Livestock grazing

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, the risk of seepage, and the steepness of slope in some areas.
- Shallow rooting depth of the Stukel soil limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Deschutes soil—Pumice Flat 10-12pz
Stukel soil—Lava Blisters 10-12pz

35B—Deschutes-Stukel complex, dry, 0 to 8 percent slopes

Composition

Deschutes soil and similar inclusions—50 percent
Stukel soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Deschutes soil—western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass; Stukel soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Typical Profile of the Stukel Soil

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Properties and Qualities of the Stukel Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Redmond soils in swales
- Soils that have a loamy sand surface layer
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, slope, permeability, climate

General Management Considerations

Irrigated cropland

- Because the Stukel soil is shallow, intensive irrigation water management is needed for crop production.
- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, these soils are subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

• Because of the steepness of slope and undulating topography, sprinkler irrigation systems are best suited to this unit.

Livestock grazing

• Care should be taken to protect the soils from wind erosion when applying range improvement practices.
• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth and risk of seepage.
• The low annual precipitation and restricted depth of the Stukel soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Deschutes soil—Pumice Flat 8-10pz
Stukel soil—Lava Blisters 8-10pz

36A—Deskamp loamy sand, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 17 inches—brown loamy sand
17 to 32 inches—pale brown gravelly loamy sand
32 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 3 inches

Contrasting Inclusions

• Clovkamp soils in swales
• Gosney soils on ridges
• Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability

General Management Considerations

Irrigated cropland

• Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
• Because the surface layer is loamy sand, this soil is subject to wind erosion if left unprotected.
• Because of the surface texture, the water infiltration rate is high, which restricts the type of irrigation system that can be used.
• Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the rapid permeability of the soil.
• The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth and risk of seepage.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

36B—Deskamp loamy sand, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet

Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 17 inches—brown loamy sand
17 to 32 inches—pale brown gravelly loamy sand
32 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Clovkamp soils in swales
- Gosney soils on ridges
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability, slope

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is loamy sand, this soil is subject to wind erosion if left unprotected.
- Because of the surface texture, the water infiltration rate is high, which restricts the type of irrigation system that can be used.
- Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the rapid permeability of the soil.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

37B—Deskamp sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 17 inches—brown sandy loam
17 to 32 inches—pale brown gravelly loamy sand
32 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that have a loamy sand or loamy coarse sand surface layer
- Gosney soils on ridges
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability, slope

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the rapid permeability of the soil.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

38B—Deskamp-Gosney complex, 0 to 8 percent slopes

Composition

Deskamp soil and similar inclusions—50 percent
Gosney soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Deskamp soil—swales; Gosney soil—mounds
Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Deskamp soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread; Gosney soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Deskamp Soil

0 to 17 inches—brown loamy sand
17 to 32 inches—pale brown gravelly loamy sand
32 inches—basalt

Properties and Qualities of the Deskamp Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 3 inches

Typical Profile of the Gosney Soil

0 to 2 inches—grayish brown stony loamy sand
2 to 14 inches—grayish brown and pale brown loamy sand
14 inches—basalt

Properties and Qualities of the Gosney Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 1 inch

Contrasting Inclusions

- Clovkamp soils in swales
- Soils that are very shallow to bedrock and are on ridges
- Rock outcrop

Major Uses

Livestock grazing, irrigated cropland

Major Management Limitations

Deskamp and Gosney soils—surface texture, soil depth, permeability, slope, available water capacity
Gosney soil—rock fragments in surface layer

General Management Considerations

Livestock grazing

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- Shallow rooting depth of the Gosney soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by

the rock fragments on the surface of the Gosney soil.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Irrigated cropland

• Because the surface layer is loamy sand, these soils are subject to wind erosion if left unprotected.
• Because of the surface texture, the water infiltration rate is high, which restricts the type of irrigation system that can be used.
• Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the rapid permeability of the soils.
• Because of the low available water capacity, intensive irrigation water management is needed.
• The rock fragments on the surface of the Gosney soil interfere with farming operations.
• The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.
• Because of the steepness of slope and undulating topography, sprinkler irrigation systems are best suited to this unit.

Range Site

Deskamp soil—Pumice Flat 10-12pz
Gosney soil—Lava Blisters 10-12pz

39A—Dester gravelly loamy sand, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over old alluvium
Elevation: 4,200 to 4,800 feet
Native plants: Mountain big sagebrush, western needlegrass, Ross sedge, bottlebrush squirreltail
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 17 inches—grayish brown gravelly loamy sand
17 to 24 inches—brown clay loam
24 to 34 inches—light yellowish brown gravelly clay loam
34 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

• Ninemile soils on lava plains
• Borobey soils in small basins and along drainageways
• Choptie soils on knolls and hills

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice Flat 9-11pz

40B—Dester sandy loam, 0 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over old alluvium
Elevation: 4,200 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical profile

0 to 17 inches—grayish brown sandy loam
17 to 24 inches—brown clay loam
24 to 34 inches—light yellowish brown gravelly clay loam
34 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Ninemile soils on lava plains
- Borobey soils in small basins and along drainageways
- Choptie soils on knolls and hills

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice 8-10pz

41C—Douthit sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, white fir, snowbrush, chinkapin, pinegrass
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 10 to 20 inches
- Belrick soils that are south of Canyon Creek
- Bott soils on side slopes
- Kweo soils on cinder cones

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-C2-12

41D—Douthit sandy loam, 15 to 30 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, white fir, snowbrush, chinkapin, pinegrass
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 10 to 20 inches
- Belrick soils that are south of Canyon Creek
- Bott soils on side slopes and ridges
- Kweo soils on cinder cones
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-C2-12

41E—Douthit sandy loam, 30 to 50 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, white fir, snowbrush, chinkapin, pinegrass
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 10 to 20 inches
- Belrick soils that are south of Canyon Creek
- Bott soils on side slopes and ridges
- Kweo soils on cinder cones
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-C2-12

42C—Douthit sandy loam, cool, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 4,400 to 5,200 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—60 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 30 days

Typical profile

2 inches to 0—organic mat
0 to 3 inches—very dark grayish brown sandy loam
3 to 12 inches—dark yellowish brown cobbly sandy loam
12 to 62 inches—dark brown extremely stony sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 10 to 20 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 10 to 20 inches
- Kweo soils on cinder cones

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-13

43A—Embal sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Alluvial fans, narrow flood plains
Parent material: Alluvium derived from basalt, welded tuff, and ash
Elevation: 4,000 to 4,600 feet
Native plants: Basin big sagebrush, basin wildrye, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 20 inches—grayish brown and brown sandy loam
20 to 30 inches—brown sandy loam
30 to 60 inches—grayish brown gravelly sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Contrasting Inclusions

- Ninemile soils on lava plains
- Beden soils along drainageways and on side slopes
- Reluctan soils on toe slopes

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Swale 10-14pz

44B—Era sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landscape position: Foot slopes
Landform: Hills
Parent material: Ash over old alluvium
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, needleandthread, Indian ricegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 10 inches—brown sandy loam
10 to 60 inches—pale brown sandy loam

Soil Properties and Qualities

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

Contrasting Inclusions

- Soils that are similar to this Era soil but have a very cobbly substratum
- Era soils that have slopes of more than 8 percent
- Caphealy and Reuter soils

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, slope, permeability, climate

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice Hills 8-10pz

45A—Era sandy loam, cobbly substratum, 0 to 3 percent slopes

Composition

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

Setting

Landscape position: Swales
Landform: Hills
Parent material: Ash over old alluvium
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, needleandthread, Indian ricegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 10 inches—brown sandy loam
10 to 42 inches—pale brown sandy loam
42 to 60 inches—pale brown very cobbly sandy loam

Soil Properties and Qualities

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

Contrasting Inclusions

- Soils that are similar to this Era soil but have a very cobbly substratum at a depth of less than 40 inches

Major Uses

Irrigated cropland (fig. 5), livestock grazing

Figure 5.—Mint in an area of Era sandy loam, cobbly substratum, 0 to 3 percent slopes.

Major Management Limitations

Surface texture, permeability, climate

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice Hills 8-10pz

46B—Era-Haystack complex, 0 to 8 percent slopes

Composition

Era soil and similar inclusions—45 percent
Haystack soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Alluvial fans
Parent material: Era soil—ash over old alluvium; Haystack soil—colluvium
Elevation: 2,000 to 3,000 feet
Native plants: Era soil—western juniper, basin big sagebrush, antelope bitterbrush, needleandthread, Indian ricegrass; Haystack soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Era Soil

0 to 10 inches—brown sandy loam
10 to 42 inches—pale brown sandy loam
42 to 60 inches—pale brown very cobbly sandy loam

Properties and Qualities of the Era Soil

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

Typical Profile of the Haystack Soil

0 to 11 inches—dark grayish brown and brown loam
11 to 26 inches—brown very gravelly and extremely gravelly loam
26 to 60 inches—brown extremely gravelly loamy sand

Properties and Qualities of the Haystack Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that are very cobbly throughout

Major Use

Livestock grazing

Major Management Limitations

Surface texture, permeability, climate

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the Era soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Era soil—Pumice Hills 8-10pz
Haystack soil—Droughty 8-12pz

47A—Ermabell loamy fine sand, 0 to 3 percent slopes

Composition

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

Setting

Landform: Stream terraces
Parent material: Ash over glacial outwash
Elevation: 2,800 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

0 to 31 inches—grayish brown loamy fine sand
31 to 41 inches—grayish brown fine sand
41 to 60 inches—grayish brown very gravelly sand

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 40 inches or more; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Lundgren soils on outwash plains
- Omahaling soils on flood plains
- Poorly drained soils on bottoms

Major Use

Livestock grazing

Major Management Limitations

Climate, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the risk of seepage.

Range Site

Pine-Juniper-Bitterbrush-Fescue

48C—Flarm-Smiling complex, 0 to 15 percent slopes

Composition

Flarm soil and similar inclusions—45 percent
Smiling soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 2,500 to 4,000 feet
Native plants: Flarm soil—ponderosa pine, white fir, common snowberry, twinflower; Smiling soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—15 to 25 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Flarm Soil

4 inches to 0—organic mat
0 to 4 inches—very dark grayish brown loam
4 to 42 inches—dark brown and dark yellowish brown clay loam and gravelly clay loam
42 to 56 inches—dark yellowish brown sandy loam
56 to 65 inches—yellowish brown loam

Properties and Qualities of the Flarm Soil

Depth: Colluvium at a depth of 4 to 7 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: 6 to 24 inches below the surface in April through May
Permeability: Moderately slow
Available water capacity: About 10 inches

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 40 to 60 inches
- Soils that are poorly drained or moderately well drained

Major Use

Woodland

Major Management Limitations

Flarm and Smiling soils—low fertility, susceptibility to compaction
Flarm soil—wetness

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- The seasonal high water table in the Flarm soil restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided on the Flarm soil unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Flarm soil—CD-S6-12
Smiling soil—CP-S2-17

49A—Fluvents, 0 to 1 percent slopes

Composition

Fluvents—90 percent
Contrasting inclusions—10 percent

Setting

Landform: Flood plains (fig. 6)

Figure 6.—Area of Fluvents, 0 to 1 percent slopes, along the Crooked River. Smith Rock on right in background.

Parent material: Recent alluvium
Elevation: 1,200 to 1,500 feet
Native plants: Willow, reeds, gray rabbitbrush, green rabbitbrush, big sagebrush
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Representative profile

0 to 4 inches—very dark grayish brown loamy sand
4 to 26 inches—very dark grayish brown sand
26 to 35 inches—dark grayish brown very fine sand
35 to 60 inches—dark brown coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained to excessively drained
Permeability: Rapid
Available water capacity: About 5 inches
Flooding: Rare because of upstream flood control

Contrasting Inclusions

- Gravel bars
- Soils that are poorly drained

Major Use

Wildlife habitat

Major Management Limitation

Rare flooding

Range Site

Loamy Bottom

50C—Gap sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 4,000 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, white fir, common snowberry, pinegrass
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical profile:

4 inches to 0—organic mat
0 to 14 inches—dark brown and reddish brown sandy loam
14 to 18 inches—reddish brown loam
18 to 47 inches—dark brown and reddish brown clay loam
47 inches—weathered tuff

Soil Properties and Qualities

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 8 inches

Contrasting Inclusions

- Glaze soils on side slopes

- Prairie soils on side slopes and ridges
- Poorly drained soils in depressions
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-14

51D—Gap-Glaze complex, 15 to 30 percent slopes

Composition

Gap soil and similar inclusions—45 percent
Glaze soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 4,000 to 5,000 feet
Native plants: Gap soil—ponderosa pine, Douglas fir, white fir, common snowberry, pinegrass; Glaze soil—ponderosa pine, white fir, snowbrush, chinkapin, pinegrass
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile of the Gap Soil

4 inches to 0—organic mat
0 to 14 inches—dark brown and reddish brown sandy loam
14 to 18 inches—reddish brown loam
18 to 47 inches—dark brown and reddish brown clay loam
47 inches—weathered tuff

Properties and Qualities of the Gap Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 8 inches

Typical Profile of the Glaze Soil

3 inches to 0—organic mat
0 to 4 inches—dark yellowish brown sandy loam
4 to 19 inches—dark brown cobbly sandy loam
19 to 54 inches—dark brown extremely stony loam
54 inches—weathered tuff

Properties and Qualities of the Glaze Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 5 inches

Contrasting Inclusions

- Prairie soils on side slopes and ridges
- Rock outcrop

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Gap soil—CD-S6-14
Glaze soil—CW-C2-12

52B—Gardone sand, 3 to 10 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 4,200 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 10 inches—dark grayish brown sand
10 to 60 inches—grayish brown and pale brown loamy sand

Soil Properties and Qualities

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

Contrasting Inclusions

- Areas of moderately deep and deep ash deposits over a buried soil on basalt pressure ridges
- Choptie soils on knolls and hills
- Borobey soils along drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice 8-10pz

53C—Gardone sand, hummocky, 3 to 15 percent slopes

Composition

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

Setting

Landform: Dunes on lava plains
Parent material: Ash
Elevation: 4,000 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 10 inches—dark grayish brown sand
10 to 60 inches—grayish brown and pale brown loamy sand

Soil Properties and Qualities

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

Contrasting Inclusions

- Borobey soils along drainageways
- Areas of moderately deep and deep ash deposits over a buried soil on basalt pressure ridges
- Stookmoor soils along adjacent lava plains
- Blayden soils along drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice 8-10pz

54C—Gardone sand, moist, 3 to 20 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over buried soil material
Elevation: 4,000 to 4,800 feet
Native plants: Mountain big sagebrush, antelope bitterbrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 10 inches—dark grayish brown sand
10 to 41 inches—grayish brown and pale brown loamy sand
41 to 60 inches—pale brown loam

Soil Properties and Qualities

Depth: Buried soil material at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Rapid over moderate
Available water capacity: About 6 inches

Contrasting Inclusions

- Borobey and Blayden soils along drainageways
- Areas of moderately deep ash deposits over a buried soil on basalt pressure ridges
- Stookmoor soils along adjacent lava plains

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage and the steepness of slope in some areas.

Range Site

Pumice 10-12pz

55A—Gardone-Borobey complex, 0 to 5 percent slopes

Composition

Gardone soil and similar inclusions—60 percent
Borobey soil and similar inclusions—30 percent
Contrasting inclusions—10 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 4,200 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Gardone Soil

0 to 10 inches—dark grayish brown sand
10 to 60 inches—grayish brown and pale brown loamy sand

Properties and Qualities of the Gardone Soil

Depth: Bedrock at a depth of 60 inches or more

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: About 6 inches

Typical Profile of the Borobey Soil

0 to 21 inches—grayish brown and brown sandy loam
21 to 51 inches—pale brown sandy loam
51 to 60 inches—pale brown clay loam

Properties and Qualities of the Borobey Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately slow
Available water capacity: About 5 inches

Contrasting Inclusions

- Blayden soils along drainageways
- Rock outcrop along pressure ridges and fault escarpments

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice 8-10pz

56E—Glaze-Prairie-Rock outcrop complex, 30 to 50 percent slopes

Composition

Glaze soil and similar inclusions—35 percent
Prairie soil and similar inclusions—35 percent
Rock outcrop—15 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 4,000 to 5,000 feet
Native plants: Glaze soil—ponderosa pine, white fir, snowbrush, chinkapin, pinegrass; Prairie soil—ponderosa pine, Douglas fir, white fir, common snowberry, pinegrass
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile of the Glaze Soil

3 inches to 0—organic mat
0 to 4 inches—dark yellowish brown sandy loam
4 to 19 inches—dark brown cobbly sandy loam
19 to 54 inches—dark brown extremely stony loam
54 inches—weathered tuff

Properties and Qualities of the Glaze Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 5 inches

Typical Profile of the Prairie Soil

3 inches to 0—organic mat
0 to 16 inches—dark brown and dark yellowish brown sandy loam
16 to 22 inches—dark brown gravelly loam
22 to 37 inches—dark brown cobbly loam
37 inches—weathered basalt

Properties and Qualities of the Prairie Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Gap soils on ridges

Major Use

Woodland

Major Management Limitations

Rock outcrop, slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the steepness of slope, machinery should be used only in areas covered with logging slash or brush to minimize soil displacement.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Glaze soil—CW-C2-12
Prairie soil—CD-S6-14

57B—Gosney stony loamy sand, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 2 inches—grayish brown stony loamy sand
2 to 14 inches—grayish brown loamy sand
14 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 1 inch

Contrasting Inclusions

- Deskamp soils in swales
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, rock fragments in surface layer

General Management Considerations

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The restricted soil depth limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Lava Blisters 10-12pz

58C—Gosney-Rock outcrop-Deskamp complex, 0 to 15 percent slopes

Composition

Gosney soil and similar inclusions—50 percent
Rock outcrop—25 percent
Deskamp soil and similar inclusions—20 percent
Contrasting inclusions—5 percent

Setting

Landscape position: Gosney soil—mounds; Deskamp soil—swales
Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Gosney soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch

wheatgrass, Idaho fescue; Deskamp soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Gosney Soil

0 to 2 inches—grayish brown stony loamy sand
2 to 14 inches—grayish brown and pale brown loamy sand
14 inches—basalt

Properties and Qualities of the Gosney Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 1 inch

Typical Profile of the Deskamp Soil

0 to 17 inches—brown loamy sand
17 to 32 inches—pale brown gravelly loamy sand
32 inches—basalt

Properties and Qualities of the Deskamp Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Clovkamp soils in swales
- Soils that are very shallow to bedrock

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, surface texture, soil depth, permeability, rock fragments in surface layer

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Gosney soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface of the Gosney soil.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Gosney soil—Lava Blisters 10-12pz
Deskamp soil—Pumice Flat 10-12pz

59C—Gosney-Rock outcrop-Deskamp complex, dry, 0 to 15 percent slopes

Composition

Gosney soil and similar inclusions—50 percent
Rock outcrop—25 percent
Deskamp soil and similar inclusions—20 percent
Contrasting inclusions—5 percent

Setting

Landscape position: Gosney soil—mounds; Deskamp soil—swales
Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Gosney soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass; Deskamp soil—western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile of the Gosney Soil

0 to 2 inches—grayish brown stony loamy sand
2 to 14 inches—grayish brown and pale brown loamy sand
14 inches—basalt

Properties and Qualities of the Gosney Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 1 inch

Typical Profile of the Deskamp Soil

0 to 17 inches—brown loamy sand
17 to 32 inches—pale brown gravelly loamy sand
32 inches—basalt

Properties and Qualities of the Deskamp Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Clovkamp soils in swales
- Soils that are very shallow to bedrock

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, surface texture, soil depth, permeability, rock fragments in surface layer, climate

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope in some areas.
- The restricted depth of the Gosney soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface of the Gosney soil.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Gosney soil—Lava Blisters 8-10pz
Deskamp soil—Pumice Flat 8-10pz

60C—Haynap very gravelly loamy coarse sand, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash and scoria
Elevation: 3,500 to 5,200 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 15 inches—black and dark brown very gravelly loamy coarse sand
15 to 29 inches—black extremely gravelly loamy coarse sand
29 to 49 inches—very dark gray and black loamy fine sand
49 to 62 inches—dark brown sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Very rapid over moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Belrick soils on side slopes and ridges
- Linksterly soils on side slopes

Major Use

Woodland

Major Management Limitations

Available water capacity, rock fragments in surface layer, low fertility

General Management Considerations

- Seedlings have a moderate survival rate because of the low available water capacity of the soil.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- The rock fragments in the surface layer restrict the planting of seedlings.

Forest Service Plant Association

CD-S6-13

60D—Haynap very gravelly loamy coarse sand, 15 to 30 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash and scoria
Elevation: 3,500 to 5,200 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 15 inches—black and dark brown very gravelly loamy coarse sand
15 to 29 inches—black extremely gravelly loamy coarse sand
29 to 49 inches—very dark gray and black loamy fine sand
49 to 62 inches—dark brown sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Very rapid over moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Belrick soils on side slopes and ridges
- Linksterly soils on side slopes

Major Use

Woodland

Major Management Limitations

Available water capacity, rock fragments in surface layer, slope, low fertility

General Management Considerations

- Seedlings have a moderate survival rate because of the low available water capacity of the soil.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- The rock fragments in the surface layer restrict the planting of seedlings.

Forest Service Plant Association

CD-S6-13

60E—Haynap very gravelly loamy coarse sand, 30 to 70 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash and scoria
Elevation: 3,500 to 5,200 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 15 inches—black and dark brown very gravelly loamy coarse sand
15 to 29 inches—black extremely gravelly loamy coarse sand
29 to 49 inches—very dark gray and black loamy fine sand
49 to 62 inches—dark brown sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained

Permeability: Very rapid over moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Belrick soils on side slopes and ridges
- Linksterly soils on side slopes

Major Use

Woodland

Major Management Limitations

Available water capacity, rock fragments in surface layer, slope, low fertility

General Management Considerations

- Seedlings have a moderate survival rate because of the low available water capacity of the soil.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- The rock fragments in the surface layer restrict the planting of seedlings.

Forest Service Plant Association

CD-S6-13

61C—Henkle-Fryrear-Lava flows complex, 0 to 15 percent slopes

Composition

Henkle soil and similar inclusions—40 percent
Fryrear soil and similar inclusions—35 percent
Lava flows—15 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Western juniper, ponderosa pine, mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Henkle Soil

0.5 inch to 0—organic mat on surface
0 to 17 inches—very dark brown and dark brown very cobbly sandy loam
17 inches—basalt

Properties and Qualities of the Henkle Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: About 1.5 inches

Typical Profile of the Fryrear Soil

0.5 inch to 0—organic mat on surface
0 to 3 inches—dark brown stony sandy loam
3 to 18 inches—dark brown very stony sandy loam
18 to 27 inches—dark yellowish brown very stony sandy loam
27 inches—basalt

Properties and Qualities of the Fryrear Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2.5 inches

Contrasting Inclusions

- Fremkle soils on ridges
- Laidlaw soils in swales
- Wanoga soils on side slopes and ridges

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, soil depth, available water capacity, permeability, rock fragments in surface layer, low fertility, susceptibility to compaction, Lava flows

General Management Considerations

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope in some areas.
- The restricted depth of the Henkle soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The areas of Lava flows limit the areas suitable for grazing and restrict accessibility by livestock.

Woodland

- Seedlings have a poor survival rate because of the low precipitation and low available water capacity.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- The rock fragments on the surface and the areas of Lava flows can interfere with felling, yarding, and other operations involving equipment use.
- Because roots are restricted by the limited depth of the Henkle soil, trees are subject to windthrow.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soils.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- The areas of Lava flows force yarding and skidding paths to converge, which increases the risks of compaction and erosion throughout the unit.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Juniper-Pine-Fescue

62D—Henkle-Lava flows-Fryrear complex, 15 to 50 percent slopes

Composition

Henkle soil and similar inclusions—35 percent
Lava flows—30 percent
Fryrear soil and similar inclusions—25 percent
Contrasting inclusions—10 percent

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Western juniper, ponderosa pine, mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Henkle Soil

0.5 inch to 0—organic mat on surface
0 to 17 inches—very dark brown and dark brown very cobbly sandy loam
17 inches—basalt

Properties and Qualities of the Henkle Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: About 1.5 inches

Typical Profile of the Fryrear Soil

0.5 inch to 0—organic mat on surface
0 to 3 inches—dark brown stony sandy loam
3 to 18 inches—dark brown very stony sandy loam
18 to 27 inches—dark yellowish brown very stony sandy loam
27 inches—basalt

Properties and Qualities of the Fryrear Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2.5 inches

Contrasting Inclusions

- Fremkle soils on ridges
- Laidlaw soils in swales
- Wanoga soils on side slopes and ridges

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, soil depth, available water capacity, permeability, rock fragments in surface layer, slope, low fertility, susceptibility to compaction, Lava flows

General Management Considerations

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Henkle soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The areas of Lava flows limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.

Woodland

- Seedlings have a poor survival rate because of the low precipitation and low available water capacity.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- The rock fragments on the surface and the areas of Lava flows can interfere with felling, yarding, and other operations involving equipment use.
- Because roots are restricted by the limited rooting depth of the Henkle soil, trees are subject to windthrow.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soils.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Using machinery only in areas covered with logging slash or brush reduces soil displacement.
- The areas of Lava flows force yarding and skidding paths to converge, which increases the risks of compaction and erosion throughout the unit.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Juniper-Pine-Fescue

63C—Holmzie-Searles complex, 0 to 15 percent slopes

Composition

Holmzie soil and similar inclusions—50 percent
Searles soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash over residuum
Elevation: 2,500 to 3,500 feet
Native plants: Holmzie soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread; Searles soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Holmzie Soil

0 to 7 inches—dark grayish brown loam
7 to 19 inches—brown clay loam
19 to 29 inches—reddish brown gravelly clay
29 inches—weathered tuff

Properties and Qualities of the Holmzie Soil

Depth: Soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 5 inches

Typical Profile of the Searles Soil

0 to 7 inches—grayish brown sandy loam
7 to 13 inches—brown loam
13 to 24 inches—brown and yellowish brown very gravelly loam and very gravelly clay loam
24 inches—basalt

Properties and Qualities of the Searles Soil

Depth: Bedrock at a depth of 20 to 40 inches

Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that are on ridges and have bedrock at a depth of 10 to 20 inches
- Soils that are in swales and have a clay or clay loam subsoil over a strongly cemented duripan at a depth of 20 to 40 inches
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Holmzie soil—soil depth, climate
Searles soil—soil depth, climate, surface texture

General Management Considerations

- Care should be taken to protect the Searles soil from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development on these soils is limited by the soil depth and the steepness of slope in some areas.
- The low annual precipitation limits productivity and limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Holmzie soil—Pumice Flat 10-12pz
Searles soil—Droughty 8-12pz

64C—Holmzie-Searles complex, moist, 0 to 15 percent slopes

Composition

Holmzie soil and similar inclusions—50 percent
Searles soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash over residuum
Elevation: 3,500 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Holmzie Soil

0 to 7 inches—dark grayish brown loam
7 to 19 inches—brown clay loam
19 to 29 inches—reddish brown gravelly clay
29 inches—weathered tuff

Properties and Qualities of the Holmzie Soil

Depth: Soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 5 inches

Typical Profile of the Searles Soil

0 to 7 inches—grayish brown sandy loam
7 to 13 inches—brown loam
13 to 24 inches—brown and yellowish brown very gravelly loam and very gravelly clay loam
24 inches—basalt

Properties and Qualities of the Searles Soil

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

Contrasting Inclusions

- Soils that are on ridges and have bedrock at a depth of 10 to 20 inches
- Soils that have a stony or very stony surface layer
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitation

Soil depth

General Management Considerations

- Pond development is limited by the soil depth and the steepness of slope in some areas.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pine-Juniper-Bitterbrush-Fescue

65A—Houstake sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, and needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 5 inches—brown sandy loam
5 to 22 inches—brown sandy loam
22 to 60 inches—light brownish gray and brown sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 7 inches

Contrasting Inclusions

- Stukel soils on ridges
- Redmond and Statz soils in swales
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

66A—Houstake sandy loam, dry, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, needleandthread, Idaho fescue, and western needlegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile

0 to 5 inches—brown sandy loam
5 to 22 inches—brown sandy loam
22 to 60 inches—light brownish gray and brown sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 7 inches

Contrasting Inclusions

- Stukel soils on ridges
- Redmond and Statz soils in swales
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability, climate

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 8-10pz

67A—Houstake sandy loam, very gravelly substratum, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, and needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 6 inches—brown sandy loam
6 to 22 inches—brown loamy sand
22 to 41 inches—light grayish brown sandy loam
41 to 60 inches—light grayish brown very gravelly sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 5 inches

Contrasting Inclusions

- Stukel soils on ridges
- Redmond and Statz soils in swales
- Rock outcrop

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice Flat 10-12pz

68A—Iris silt loam, 0 to 1 percent slopes

Composition

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

Setting

Landscape position: Lake basins
Landform: Lava plains
Parent material: Alluvium derived from loess
Elevation: 2,500 to 3,000 feet
Climatic factors:
Mean annual precipitation—8 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical profile

0 to 14 inches—brown silt loam
14 to 34 inches—pale brown silt loam
34 to 60 inches—pale brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 11.5 inches

Contrasting Inclusions

- Agency soils adjacent to basins

Major Use

Irrigated cropland

Major Management Limitation

Surface texture

General Management Considerations

- The silt loam surface layer is subject to compaction from excessive tillage.

69D—Kweo gravelly sandy loam, 8 to 50 percent slopes

Composition

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

Setting

Landform: Cinder cones
Parent material: Ash over cinders
Elevation: 3,200 to 5,200 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 13 inches—dark brown gravelly sandy loam
13 to 25 inches—dark reddish brown very gravelly sandy loam
25 to 60 inches—dark yellowish brown cinders

Soil Properties and Qualities

Depth: Cinders at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that are similar to the Kweo soil but have cinders at a depth of more than 35 inches
- Linksterly soils on toe slopes
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, rooting depth, rock fragments in surface layer, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires of moderate fireline intensity on south-facing slopes.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-13

70D—Kweo-Smiling complex, 8 to 50 percent slopes

Composition

Kweo soil and similar inclusions—60 percent
Smiling soil and similar inclusions—25 percent
Contrasting inclusions—15 percent

Setting

Landform: Kweo soil—cinder cones; Smiling soil—mountains
Parent material: Kweo soil—ash over cinders; Smiling soil—ash over colluvium
Elevation: 3,200 to 4,000 feet
Native plants: Kweo soil—ponderosa pine, Douglas fir, common snowberry, forbs; Smiling soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile of the Kweo Soil

1 inch to 0—organic mat
0 to 13 inches—dark brown gravelly sandy loam
13 to 25 inches—dark reddish brown very gravelly sandy loam
25 to 60 inches—dark yellowish brown cinders

Properties and Qualities of the Kweo Soil

Depth: Cinders at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 3 inches

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Bott and Windego soils on side slopes
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Kweo and Smiling soils—slope, low fertility, susceptibility to compaction
Kweo soil—rooting depth, rock fragments in surface layer

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because the coarse-textured Kweo soil has insufficient anchoring capability, trees are subject to windthrow.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires of moderate fireline intensity on the Kweo soil.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Using machinery only in areas covered with logging slash or brush reduces soil displacement.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Kweo soil—CD-S6-13
Smiling soil—CP-S2-17

71A—Lafollette sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Stream terraces
Parent material: Ash over old alluvium
Elevation: 2,500 to 2,800 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, and needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 24 inches—brown sandy loam
24 to 42 inches—pale brown very gravelly sandy loam
42 to 60 inches—dark gray extremely gravelly loamy coarse sand

Soil Properties and Qualities

Depth: Very gravelly substratum at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 4 inches

Contrasting Inclusions

• Soils that have weathered tuffaceous rock at a depth of 30 to 60 inches

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

• Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

71B—Lafollette sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Stream terraces
Parent material: Ash over old alluvium
Elevation: 2,500 to 2,800 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 24 inches—brown sandy loam
24 to 42 inches—pale brown very gravelly sandy loam
42 to 60 inches—dark gray extremely gravelly loamy coarse sand

Soil Properties and Qualities

Depth: Very gravelly substratum at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 4 inches

Contrasting Inclusions

• Soils that have weathered tuffaceous rock at a depth of 30 to 60 inches

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, slope, permeability

General Management Considerations

Irrigated cropland

• Because the surface layer is sandy loam, this soil is

subject to wind erosion if left unprotected.
• Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

72C—Laidlaw sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landscape position: Swales
Landform: Hills
Parent material: Ash over old alluvium
Elevation: 2,800 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

0 to 15 inches—dark brown sandy loam
15 to 38 inches—dark yellowish brown sandy loam
38 to 60 inches—dark brown fine sandy loam and loamy fine sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 8 inches

Contrasting Inclusions

• Fryrear and Wanoga soils on side slopes
• Rock outcrop

Major Uses

Woodland, livestock grazing

Major Management Limitations

Climate, low fertility, susceptibility to compaction, surface texture, permeability

General Management Considerations

Woodland

• Seedlings have a moderate survival rate because of the low precipitation.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Livestock grazing

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the risk of seepage and the steepness of slope in some areas.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pine-Juniper-Bitterbrush-Fescue

73C—Lapine gravelly loamy coarse sand, 0 to 15 percent slopes

Composition

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

Setting

Landform: Pumice-mantled lava plains
Parent material: Ash and pumice
Elevation: 4,500 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, needlegrasses
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

- Soils that are moderately well drained or somewhat poorly drained
- Soils that have bedrock at a depth of 40 to 60 inches
- Steiger soils that generally are north of Little River

Major Use

Woodland

Major Management Limitations

Soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.
- The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CP-S2-12

73D—Lapine gravelly loamy coarse sand, 15 to 30 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash and pumice
Elevation: 4,500 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, needlegrasses
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

- Soils that are moderately well drained or somewhat poorly drained
- Soils that have bedrock at a depth of 40 to 60 inches
- Steiger soils that generally are north of Little River

Major Use

Woodland

Major Management Limitations

Slope, soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.

• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.
• The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CP-S2-12

73E—Lapine gravelly loamy coarse sand, 30 to 50 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash and pumice
Elevation: 4,500 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

• Soils that have bedrock at a depth of 40 to 60 inches
• Steiger soils that generally are north of Little River

Major Use

Woodland

Major Management Limitations

Slope, soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

• Loose soil material moving downslope can cover and damage seedlings.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

• The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CP-S2-17

74C—Lapine gravelly loamy coarse sand, high elevation, 0 to 15 percent slopes

Composition

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

Setting

Landform: Pumice-mantled lava plains
Parent material: Ash and pumice
Elevation: 5,000 to 6,000 feet
Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, chinkapin
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

• Soils that have bedrock at a depth of 40 to 60 inches

Major Use

Woodland

Major Management Limitations

Soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.
• The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CW-H1-11

74D—Lapine gravelly loamy coarse sand, high elevation, 15 to 30 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash and pumice
Elevation: 5,000 to 6,000 feet
Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, chinkapin
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

• Soils that have bedrock at a depth of 40 to 60 inches

Major Use

Woodland

Major Management Limitations

Soil depth, slope, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.
- The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CW-H1-11

74E—Lapine gravelly loamy coarse sand, high elevation, 30 to 60 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash and pumice
Elevation: 5,000 to 6,000 feet
Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, and chinkapin
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 40 to 60 inches

Major Use

Woodland

Major Management Limitations

Soil depth, slope, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Loose soil material moving downslope can cover and damage seedlings.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or

crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.
• The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CW-H1-11

75A—Lapine gravelly loamy coarse sand, low, 0 to 3 percent slopes

Composition

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

Setting

Landscape position: Depressions
Landform: Pumice-mantled lava plains
Parent material: Ash and pumice
Elevation: 4,200 to 4,500 feet
Native plants: Lodgepole pine, antelope bitterbrush, sedges
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 30 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

• Soils that are moderately well drained or somewhat poorly drained

Major Use

Woodland

Major Management Limitations

Frost hazard, soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

• Severe frost or frost heaving can damage or kill seedlings.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.
• The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CL-S2-12

76F—Lapine-Rock outcrop complex, high elevation, 50 to 70 percent slopes

Composition

Lapine soil and similar inclusions—75 percent
Rock outcrop—15 percent
Contrasting inclusions—10 percent

Setting

Landform: Pumice plains
Parent material: Volcanic ash and pumice
Elevation: 5,000 to 6,000 feet

Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, chinkapin
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

1 inch to 0—organic mat
0 to 7 inches—dark brown gravelly loamy coarse sand
7 to 37 inches—very pale brown and light gray extremely gravelly coarse sand and very gravelly loamy coarse sand
37 to 60 inches—light gray gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Very rapid
Available water capacity: About 9 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 40 to 60 inches

Major Use

Woodland

Major Management Limitations

Rock outcrop, soil depth, slope, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Loose soil material moving downslope can cover and damage seedlings.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.
- The coarse texture of the soil and the inherent low fertility of the subsoil and substratum restrict root development.

Forest Service Plant Association

CW-H1-11

77—Lava flows

Composition

Lava flows—85 percent
Contrasting inclusions—15 percent

Setting

Slope: 0 to 50 percent
Elevation: 3,200 to 5,200 feet
Climatic factors:
Mean annual precipitation—30 to 50 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Description of Lava flows

Lateral hardened rock consisting of cooled molten lava

Contrasting Inclusions

- Soils that have bedrock at a depth of 1 inch to 20 inches

Major Use

Wildlife habitat

78C—Lickskillet-Deschutes complex, 0 to 15 percent slopes

Composition

Lickskillet soil and similar inclusions—45 percent
Deschutes soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Lickskillet soil—hills; Deschutes soil—lava plains
Parent material: Lickskillet soil—colluvium; Deschutes soil—ash

Elevation: 2,500 to 3,500 feet
Native plants: Lickskillet soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass; Deschutes soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Contrasting Inclusions

- Houstake soils in swales

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, rock fragments in surface layer

General Management Considerations

- Care should be taken to protect these soils from wind erosion when applying range improvement practices.
- Because the Deschutes soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and the steepness of slope in some areas.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.

Range Site

Lickskillet soil—Droughty 8-12pz
Deschutes soil—Pumice Flat 10-12pz

79C—Lickskillet-Redcliff very gravelly loams, 0 to 15 percent slopes

Composition

Lickskillet soil and similar inclusions—45 percent
Redcliff soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Lickskillet soil—knobs and ridges; Redcliff soil—side slopes
Landform: Hills
Parent material: Colluvium
Elevation: 2,600 to 4,500 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Lickskillet Soil

0 to 9 inches—dark grayish brown very gravelly loam
9 to 13 inches—brown extremely gravelly loam
13 inches—fractured rhyolite

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Typical Profile of the Redcliff Soil

0 to 19 inches—brown very gravelly loam
19 to 25 inches—dark yellowish brown extremely gravelly clay loam
25 inches—fractured rhyolite

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Contrasting Inclusions

- Madras and Agency soils on toe slopes
- Era soils on north aspects

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability

General Management Considerations

- Pond development is limited by the soil depth, the risk of seepage, and the steepness of slope in some areas.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty 8-12pz

80D—Lickskillet-Redcliff very gravelly loams, 15 to 30 percent south slopes

Composition

Lickskillet soil and similar inclusions—45 percent
Redcliff soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Lickskillet soil—knobs and ridges; Redcliff soil—side slopes
Landform: Hills
Parent material: Colluvium
Elevation: 2,600 to 4,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Lickskillet Soil

0 to 9 inches—dark grayish brown very gravelly loam
9 to 13 inches—brown extremely gravelly loam
13 inches—fractured rhyolite

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Typical Profile of the Redcliff Soil

0 to 19 inches—brown very gravelly loam
19 to 25 inches—dark yellowish brown extremely gravelly clay loam
25 inches—fractured rhyolite

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Contrasting Inclusions

- Simas soils that are on side slopes and ridges and support low sagebrush
- Era soils in swales
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, slope

General Management Considerations

- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

South 9-12pz

80E—Lickskillet-Redcliff very gravelly loams, 30 to 60 percent south slopes

Composition

Lickskillet soil and similar inclusions—45 percent
Redcliff soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Lickskillet soil—knobs and ridges; Redcliff soil—side slopes
Landform: Hills
Parent material: Colluvium
Elevation: 2,600 to 4,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Lickskillet Soil

0 to 9 inches—dark grayish brown very gravelly loam
9 to 13 inches—brown extremely gravelly loam
13 inches—fractured rhyolite

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Typical Profile of the Redcliff Soil

0 to 19 inches—brown very gravelly loam
19 to 25 inches—dark yellowish brown extremely gravelly clay loam
25 inches—fractured rhyolite

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Contrasting Inclusions

- Simas soils that are on side slopes and ridges and support low sagebrush
- Era soils in swales
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, slope

General Management Considerations

- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
- The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

South 9-12pz

81F—Lickskillet-Rock outcrop complex, 45 to 80 percent slopes

Composition

Lickskillet soil and similar inclusions—60 percent
Rock outcrop—35 percent
Contrasting inclusions—5 percent

Setting

Position on landscape: South-facing side slopes
Landform: Canyonsides
Parent material: Colluvium
Elevation: 2,000 to 4,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Contrasting Inclusions

• Deep soils that are sandy throughout

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, soil depth, climate, surface stones, slope

General Management Considerations

• The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
• The steepness of slope, areas of Rock outcrop, and stones on the surface restrict livestock distribution and restrict range seeding with ground equipment.
• The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

South 9-12pz

82C—Linksterly sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

3 inches to 0—organic mat
0 to 14 inches—very dark grayish brown sandy loam
14 to 41 inches—black and very dark grayish brown loamy fine sand
41 to 60 inches—dark reddish brown very cobbly sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

• Belrick soils on side slopes and ridges
• Douthit soils on ridges
• Haynap soils that are south of Round Lake and are on side slopes

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-13

82D—Linksterly sandy loam, 15 to 30 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, and forbs
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

3 inches to 0—organic mat
0 to 14 inches—very dark grayish brown sandy loam
14 to 41 inches—black and very dark grayish brown loamy fine sand
41 to 60 inches—dark reddish brown very cobbly sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

- Belrick soils on side slopes and ridges
- Douthit soils on ridges
- Haynap soils that are south of Round Lake and are on side slopes

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-13

82E—Linksterly sandy loam, 30 to 50 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 4,400 feet
Native plants: Ponderosa pine, Douglas fir, common snowberry, forbs
Climatic factors:
Mean annual precipitation—50 to 60 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

3 inches to 0—organic mat
0 to 14 inches—very dark grayish brown sandy loam
14 to 41 inches—black and very dark grayish brown loamy fine sand
41 to 60 inches—dark reddish brown very cobbly sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

- Belrick soils on side slopes and ridges
- Douthit soils on ridges
- Haynap soils that are south of Round Lake and are on side slopes

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using

sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-13

83C—Linksterly sandy loam, cool, 0 to 15 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 4,400 to 5,200 feet
Native plants: Lodgepole pine, beargrass
Climatic factors:
Mean annual precipitation—60 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 30 days

Typical Profile

3 inches to 0—organic mat
0 to 14 inches—very dark grayish brown sandy loam
14 to 41 inches—black and very dark grayish brown loamy fine sand
41 to 60 inches—dark reddish brown very cobbly sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

• Belrick soils on side slopes and ridges
• Douthit soils on ridges
• Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Frost hazard, low fertility, susceptibility to compaction

General Management Considerations

• Severe frost or frost heaving can damage or kill seedlings.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CL-M4-11

83D—Linksterly sandy loam, cool, 15 to 30 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 4,400 to 5,200 feet
Native plants: Lodgepole pine and beargrass
Climatic factors:
Mean annual precipitation—60 to 70 inches
Mean annual air temperature—35 to 42 degrees F
Frost-free period—10 to 30 days

Typical Profile

3 inches to 0—organic mat
0 to 14 inches—very dark grayish brown sandy loam
14 to 41 inches—black and very dark grayish brown loamy fine sand
41 to 60 inches—dark reddish brown very cobbly sandy loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

- Belrick soils on side slopes and ridges
- Douthit soils on ridges
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Frost hazard, slope, low fertility, susceptibility to compaction

General Management Considerations

- Severe frost or frost heaving can damage or kill seedlings.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CL-M4-11

84C—Linksterly-Blowout complex, 0 to 15 percent slopes

Composition

Linksterly soil and similar inclusions—65 percent
Blowout—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 4,400 to 5,200 feet
Native plants: Lodgepole pine, beargrass
Climatic factors:
Mean annual precipitation—60 to 70 inches
Mean annual air temperature—35 to 40 degrees F
Frost-free period—10 to 30 days

Typical Profile of the Linksterly Soil

3 inches to 0—organic mat
0 to 14 inches—very dark grayish brown sandy loam
14 to 41 inches—black and very dark grayish brown loamy fine sand
41 to 60 inches—dark reddish brown very cobbly sandy loam

Properties and Qualities of the Linksterly Soil

Depth: Glacial till at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Description of Blowout

Nonvegetated depressions where the soil material has been removed by wind

Contrasting Inclusions

- Belrick soils on ridges
- Haynap soils that are north and east of Blue Lake

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction, wind erosion

General Management Considerations

- This unit is susceptible to wind erosion if the vegetation is removed.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CL-M4-11

85A—Lundgren sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 2,800 to 4,000 feet

Native plants: Ponderosa pine, antelope bitterbrush, wax currant, Idaho fescue, western needlegrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

0 to 14 inches—very dark grayish brown sandy loam
14 to 23 inches—dark brown gravelly sandy loam
23 to 38 inches—dark brown very gravelly loam
38 to 60 inches—brown extremely gravelly sandy loam

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Omahaling soils on flood plains

Major Uses

Woodland, livestock grazing

Major Management Limitations

Climate, low fertility, susceptibility to compaction, surface texture, permeability

General Management Considerations

Woodland

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pine-Bitterbrush-Fescue

86A—Madras sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 10 inches—brown sandy loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 3.5 inches

Contrasting Inclusions

- Era soils in swales
- Cullius soils on lava plains
- Caphealy and Reuter soils on hills

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability, climate

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.

• Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
• Because water soluble chemicals may be carried in the runoff, care should be taken to prevent excessive irrigation rates that may result in overland flow.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

86B—Madras sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 10 inches—brown sandy loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 3.5 inches

Contrasting Inclusions

• Era soils in swales
• Cullius soils on lava plains
• Caphealy and Reuter soils on hills

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability, slope, climate

General Management Considerations

Irrigated cropland

• Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
• Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
• Because water soluble chemicals may be carried in the runoff, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
• Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

87A—Madras loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:

Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 10 inches—brown loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Era soils in swales
- Cullius soils on lava plains
- Soils that have a silt loam surface layer

Major Uses

Irrigated cropland (fig. 7), livestock grazing

Figure 7.—Area of Madras loam, 0 to 3 percent slopes, used for production of grass seed. Mt. Jefferson is in background.

Major Management Limitations

Permeability, climate, soil depth

General Management Considerations

Irrigated cropland

- Because water soluble chemicals may be carried in the runoff, care should be taken to prevent excessive irrigation rates that may lead to overland flow.

Livestock grazing

- Pond development is limited by the soil depth.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

87B—Madras loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 10 inches—brown loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Era soils in swales
- Cullius soils on lava plains
- Soils that have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Permeability, slope, climate, soil depth

General Management Considerations

Irrigated cropland

- Because water soluble chemicals may be carried in the runoff, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Pond development is limited by the soil depth.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

87C—Madras loam, 8 to 15 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Loess over semiconsolidated sediment
Elevation: 2,000 to 3,000 feet
Native plants: Western juniper, basin big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—120 to 140 days

Typical Profile

0 to 10 inches—brown loam
10 to 23 inches—yellowish brown loam and clay loam
23 to 27 inches—semiconsolidated sediment consisting of gravel, cobbles, and sand of the Deschutes Formation
27 inches—basalt of the Deschutes Formation

Soil Properties and Qualities

Depth: Bedrock at a depth of 22 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Era soils in swales
- Cullius soils on lava plains
- Soils that have a silt loam surface layer

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Permeability, slope, climate, soil depth

General Management Considerations

Irrigated cropland

- Because water soluble chemicals may be carried in the runoff, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Pond development is limited by the soil depth.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Loam 8-10pz

88D—Menbo stony loam, 5 to 25 percent slopes

Composition

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

Setting

Landform: Hills
Parent material: Colluvium derived from basalt and welded tuff with ash on the surface
Elevation: 4,400 to 5,500 feet
Native plants: Mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, Thurber needlegrass

Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 3 inches—grayish brown stony loam
3 to 8 inches—dark grayish brown gravelly loam
8 to 26 inches—brown very cobbly clay loam
26 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Ninemile soils on lava plains and toe slopes
- Westbutte soils on steep hillsides
- Rock outcrop on knolls

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, rock fragments

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the soil depth and by the steepness of slope in some areas.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Stony Loam 10-12pz

89A—Milcan gravelly sandy loam, 0 to 5 percent slopes

Composition

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

Setting

Landscape position: Basins
Landform: Lava plains
Parent material: Ash over old alluvium
Elevation: 4,300 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 8 inches—grayish brown gravelly sandy loam
8 to 17 inches—brown loamy sand
17 to 38 inches—pale brown sandy loam
38 to 60 inches—indurated duripan

Soil Properties and Qualities

Depth: Duripan at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately slow
Available water capacity: About 6 inches

Contrasting Inclusions

- Stookmoor soils on terraces
- Borobey soils along drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice 8-10pz

90C—Minkwell sandy loam, 0 to 15 percent slopes

Composition

Minkwell soil and similar inclusions—85 percent

Contrasting inclusions—15 percent

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush, greenleaf manzanita
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 23 inches—dark brown sandy loam
23 to 34 inches—dark reddish brown cobbly loam
34 to 60 inches—dark reddish brown and dark brown cobbly clay loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Contrasting Inclusions

- Bott and Douthit soils on ridges

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-S1-12

90D—Minkwell sandy loam, 15 to 30 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush, greenleaf manzanita
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 23 inches—dark brown sandy loam
23 to 34 inches—dark reddish brown cobbly loam
34 to 60 inches—dark reddish brown and dark brown cobbly clay loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Contrasting Inclusions

- Bott and Douthit soils on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used;

however, cable yarding generally is safer and disturbs the soil less.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-S1-12

90E—Minkwell sandy loam, 30 to 50 percent slopes

Composition

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

Setting

Landform: Moraines
Parent material: Ash over glacial till
Elevation: 3,700 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush, and greenleaf manzanita
Climatic factors:
Mean annual precipitation—50 to 70 inches
Mean annual air temperature—35 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 23 inches—dark brown sandy loam
23 to 34 inches—dark reddish brown very cobbly loam
34 to 60 inches—dark reddish brown and dark brown cobbly clay loam

Soil Properties and Qualities

Depth: Glacial till at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Contrasting Inclusions

• Bott and Douthit soils on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-S1-12

91B—Ninemile sandy loam, 0 to 10 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Residuum derived from basalt with ash on the surface
Elevation: 4,200 to 4,800 feet
Native plants: Low sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 7 inches—grayish brown sandy loam
7 to 19 inches—pale brown clay and gravelly clay
19 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Very shallow soils that have a very stony surface layer and are along bedrock escarpments
- Embal and Dester soils along drainageways
- Choptie soils on hills

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.

Range Site

Pumice Claypan 9-11pz

92B—Ninemile very cobbly loam, 0 to 10 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Residuum derived from basalt
Elevation: 4,200 to 5,500 feet
Native plants: Low sagebrush, Idaho fescue, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 14 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 7 inches—grayish brown very cobbly loam
7 to 19 inches—pale brown clay and gravelly clay
19 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Very shallow soils that have a very stony surface layer and are along bedrock escarpments
- Embal and Dester soils along drainageways
- Choptie soils on hills
- Reluctan soils on lava plains

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth, rock fragments in surface layer

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the soil depth.
- Range seeding with ground equipment is limited by the rock fragments on the surface.

Range Site

Claypan 12-16pz

93B—Ninemile-Dester complex, 1 to 8 percent slopes

Composition

Ninemile soil and similar inclusions—50 percent
Dester soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ninemile soil—residuum with ash on the surface; Dester soil—ash over residuum
Elevation: 4,200 to 4,500 feet
Native plants: Ninemile soil—low sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass; Dester soil—mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Ninemile Soil

0 to 7 inches—grayish brown sandy loam
7 to 19 inches—pale brown clay and gravelly clay
19 inches—basalt

Properties and Qualities of the Ninemile Soil

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

Typical Profile of the Dester Soil

0 to 17 inches—grayish brown sandy loam
17 to 24 inches—brown clay loam
24 to 34 inches—light yellowish brown gravelly clay loam
34 inches—basalt

Properties and Qualities of the Dester Soil

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

Contrasting Inclusions

- Soils that have a stony surface layer and are along bedrock escarpments
- Borobey soils along drainageways
- Choptie soils on hills

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.

Range Site

Ninemile soil—Pumice Claypan 9-11pz
Dester soil—Pumice 8-10pz

94A—Omahaling fine sandy loam, 0 to 5 percent slopes

Composition

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

Setting

Landform: Flood plains (fig. 8)

Figure 8.—Typical area of Omahaling fine sandy loam, 0 to 5 percent slopes. Three Sisters Mountains in background.

Parent material: Ash over old alluvium
Elevation: 2,800 to 4,000 feet
Native plants: Quaking aspen, willow, sedges
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

0 to 19 inches—dark grayish brown fine sandy loam
19 to 23 inches—grayish brown silt loam
23 to 29 inches—dark gray gravelly sand
29 to 48 inches—dark grayish brown silt loam
48 to 60 inches—dark gray extremely gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained

Depth to water table: 24 to 36 inches below the surface in April through June
Permeability: Moderate over very rapid
Available water capacity: About 8 inches

Contrasting Inclusions

- Soils that are poorly drained
- Soils that have a loam surface layer and a gravelly clay loam subsoil
- Soils that have slopes of more than 5 percent
- Gravel deposits

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Permeability, slope, high water table, climate

General Management Considerations

Irrigated cropland

- Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the very rapid permeability of the substratum.
- Care should be taken when using flood irrigation on slopes of more than 3 percent.

Livestock grazing

- If seeding is needed, select plants that tolerate seasonal wetness.
- Grazing during wet periods can cause soil compaction and displacement and damage plants.
- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the risk of seepage.

Range Site

Wet Meadow

95E—Parrego-Rock outcrop-Windego complex, 30 to 50 percent slopes

Composition

Parrego soil and similar inclusions—35 percent
Rock outcrop—25 percent
Windego soil and similar inclusions—25 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 3,000 to 4,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses
Climatic factors:
Mean annual precipitation—20 to 40 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Parrego Soil

3 inches to 0—organic mat
0 to 5 inches—dark brown sandy loam
5 to 13 inches—brown loam
13 to 24 inches—brown clay loam
24 inches—weathered tuff

Properties and Qualities of the Parrego Soil

Depth: Colluvium at a depth of 4 to 7 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Contrasting Inclusions

- Smiling soils on side slopes
- Thorn soils on ridges

Major Use

Woodland

Major Management Limitations

Rock outcrop, climate, slope, low fertility, susceptibility to compaction

General Management Considerations

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less

damaging to the soil surface.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-13

96D—Parrego-Thorn-Rock outcrop complex, 15 to 50 percent slopes

Composition

Parrego soil and similar inclusions—35 percent
Thorn soil and similar inclusions—25 percent
Rock outcrop—25 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 3,000 to 4,000 feet
Native plants: Parrego soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses; Thorn soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—15 to 25 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Parrego Soil

3 inches to 0—organic mat
0 to 5 inches—dark brown sandy loam
5 to 13 inches—brown loam
13 to 24 inches—brown clay loam
24 inches—weathered tuff

Properties and Qualities of the Parrego Soil

Depth: Colluvium at a depth of 4 to 7 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Typical Profile of the Thorn Soil

1 inch to 0—organic mat
0 to 4 inches—dark brown gravelly sandy loam
4 to 8 inches—dark brown loam
8 to 16 inches—dark brown extremely stony loam
16 inches—andesite

Properties and Qualities of the Thorn Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Contrasting Inclusions

• Smiling soils on side slopes
• Windego soils on ridges

Major Use

Woodland

Major Management Limitations

Parrego and Thorn soils—Rock outcrop, climate, slope, low fertility
Thorn soil—soil depth, susceptibility to compaction

General Management Considerations

• Seedlings have a moderate survival rate because of the low precipitation.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because roots are restricted by the shallow depth of the Thorn soil, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.

• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility of the Thorn soil to compaction, designated skid trails should be used.

Forest Service Plant Association

Parrego soil—CP-S2-13
Thorn soil—CP-S2-17

97—Pits

Setting

Landform: Cinder cones
Slope: 0 to 65 percent
Elevation: 2,500 to 5,000 feet
Climatic factors:
Mean annual precipitation—10 to 25 inches
Mean annual air temperature—41 to 52 degrees F
Frost-free period—50 to 140 days

Major Use

Source of road paving material

98A—Plainview sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Outwash plains (fig. 9)
Parent material: Ash over glacial outwash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 23 inches—dark grayish brown and brown sandy loam
23 to 39 inches—pale brown very gravelly and extremely gravelly sandy loam
39 to 55 inches—light brownish gray very gravelly loamy sand
55 to 60 inches—very dark grayish brown indurated duripan

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 20 to 40 inches; duripan at a depth of 50 to 65 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

• Tumalo soils on outwash plains
• Soils that have a duripan at a depth of more than 60 inches

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

• Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the risk of seepage.

Figure 9.—Typical area of Plainview sandy loam, 0 to 3 percent slopes, in foreground. Three Sisters Mountains in background.

Range Site

Pumice Flat 10-12pz

98B—Plainview sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 23 inches—dark grayish brown and brown sandy loam
23 to 39 inches—pale brown very gravelly and extremely gravelly sandy loam
39 to 55 inches—light brownish gray very gravelly loamy sand
55 to 60 inches—very dark grayish brown indurated duripan

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 20 to 40 inches; duripan at a depth of 50 to 65 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Tumalo soils on outwash plains

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability, slope

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

99C—Prairie-Gap complex, 0 to 15 percent slopes

Composition

Prairie soil and similar inclusions—45 percent
Gap soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Mountains
Parent material: Ash over residuum and colluvium
Elevation: 4,000 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, white fir, common snowberry, pinegrass
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile of the Prairie Soil

3 inches to 0—organic mat
0 to 16 inches—dark brown and dark yellowish brown sandy loam
16 to 22 inches—dark brown gravelly loam
22 to 37 inches—dark brown cobbly loam
37 inches—weathered basalt

Properties and Qualities of the Prairie Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Typical Profile of the Gap Soil

4 inches to 0—organic mat
0 to 14 inches—dark brown and reddish brown sandy loam

14 to 18 inches—reddish brown loam
18 to 47 inches—dark brown and reddish brown clay loam
47 inches—weathered tuff

Properties and Qualities of the Gap Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 8 inches

Contrasting Inclusions

- Glaze soils on ridges

Major Use

Woodland

Major Management Limitations

Prairie and Gap soils—low fertility, susceptibility to compaction
Prairie soil—soil depth

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- On the Prairie soil, reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-14

99D—Prairie-Gap complex, 15 to 30 percent slopes

Composition

Prairie soil and similar inclusions—45 percent
Gap soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Mountains
Parent material: Ash over residuum and colluvium
Elevation: 4,000 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, white fir, common snowberry, pinegrass
Climatic factors:
Mean annual precipitation—25 to 35 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile of the Prairie Soil

3 inches to 0—organic mat
0 to 16 inches—dark brown and dark yellowish brown sandy loam
16 to 22 inches—dark brown gravelly loam
22 to 37 inches—dark brown cobbly loam
37 inches—weathered tuff

Properties and Qualities of the Prairie Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 5 inches

Typical Profile of the Gap Soil

4 inches to 0—organic mat
0 to 14 inches—dark brown and reddish brown sandy loam
14 to 18 inches—reddish brown loam
18 to 47 inches—dark brown and reddish brown clay loam
47 inches—weathered tuff

Properties and Qualities of the Gap Soil

Depth: Colluvium at a depth of 14 to 20 inches; soft bedrock at a depth of 40 to 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 8 inches

Contrasting Inclusions

- Glaze soils on ridges

Major Use

Woodland

Major Management Limitations

Prairie and Gap soils—slope, low fertility, susceptibility to compaction
Prairie soil—soil depth

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used;

however, cable yarding generally is safer and disturbs the soil less.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-14

100C—Redcliff-Lickskillet complex, 0 to 15 percent slopes

Composition

Redcliff soil and similar inclusions—60 percent
Lickskillet soil and similar inclusions—25 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Toe slopes
Landform: Hills
Parent material: Colluvium
Elevation: 2,000 to 4,500 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Redcliff Soil

0 to 10 inches—grayish brown cobbly sandy loam
10 to 25 inches—pale brown very cobbly sandy loam
25 to 34 inches—pale brown extremely cobbly sandy loam
34 inches—basalt

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Contrasting Inclusions

• Deep soils that are sandy loam and are on north- and south-facing slopes

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, rock fragments in surface layer

General Management Considerations

• Pond development is limited by the soil depth, risk of seepage, and steepness of slope in some areas.
• The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is limited by the rock fragments on the surface.

Range Site

Droughty 8-12pz

101D—Redcliff-Lickskillet-Rock outcrop complex, 15 to 30 percent south slopes

Composition

Redcliff soil and similar inclusions—60 percent
Lickskillet soil and similar inclusions—20 percent
Rock outcrop—15 percent
Contrasting inclusions—5 percent

Setting

Landscape position: Redcliff soil—toe slopes; Lickskillet soil—upper slopes
Landform: Canyonsides
Parent material: Colluvium
Elevation: 2,000 to 4,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass

Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Redcliff Soil

0 to 10 inches—grayish brown cobbly sandy loam
10 to 25 inches—pale brown very cobbly sandy loam
25 to 34 inches—pale brown extremely cobbly sandy loam
34 inches—basalt

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Contrasting Inclusions

- Soils that are deep sandy loam

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, soil depth, permeability, rock fragments in surface layer, slope

General Management Considerations

- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

South 9-12pz

101E—Redcliff-Lickskillet-Rock outcrop complex, 30 to 50 percent south slopes

Composition

Redcliff soil and similar inclusions—60 percent
Lickskillet soil and similar inclusions—20 percent
Rock outcrop—15 percent
Contrasting inclusions—5 percent

Setting

Landscape position: Redcliff soil—toe slopes; Lickskillet soil—upper slopes
Landform: Canyonsides
Parent material: Colluvium
Elevation: 2,000 to 4,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Redcliff Soil

0 to 10 inches—grayish brown cobbly sandy loam
10 to 25 inches—pale brown very cobbly sandy loam
25 to 34 inches—pale brown extremely cobbly sandy loam
34 inches—basalt

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Contrasting Inclusions

- Soils that are deep sandy loam

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, soil depth, permeability, rock fragments in surface layer, slope, aspect

General Management Considerations

- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface, the steepness of slope, and the areas of Rock outcrop.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
- The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

South 9-12pz

102D—Redcliff-Rock outcrop complex, 5 to 30 percent slopes

Composition

Redcliff soil and similar inclusions—60 percent
Rock outcrop—25 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Colluvium
Elevation: 3,000 to 4,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 12 inches
Mean annual air temperature—46 to 48 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 19 inches—brown very gravelly loam
19 to 25 inches—dark yellowish brown extremely gravelly clay loam
25 inches—fractured rhyolite

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Contrasting Inclusions

- Westbutte soils on steep, north-facing hillsides
- Stookmoor soils on hillsides
- Lickskillet soils near areas of Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, climate, soil depth

General Management Considerations

- Pond development is limited by the soil depth and the steepness of slope in some areas.
- Range seeding with ground equipment is limited by the areas of Rock outcrop.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

South 9-12pz

103E—Redcliff-Rock outcrop complex, 30 to 65 percent south slopes

Composition

Redcliff soil and similar inclusions—65 percent
Rock outcrop—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Colluvium
Elevation: 3,000 to 5,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 12 inches
Mean annual air temperature—46 to 48 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Redcliff Soil

0 to 19 inches—brown very gravelly loam

19 to 25 inches—dark yellowish brown extremely gravelly clay loam
25 inches—fractured rhyolite

Properties and Qualities of the Redcliff Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 2 inches

Contrasting Inclusions

- Westbutte soils on steep, north-facing hillsides
- Stookmoor soils on hillsides
- Lickskillet soils near areas of Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, climate, soil depth, slope

General Management Considerations

- Pond development is limited by the soil depth and steepness of slope.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
- The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

South 9-12pz

104A—Redmond sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile

0 to 12 inches—grayish brown sandy loam
12 to 21 inches—grayish brown loam
21 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: About 4 inches

Contrasting Inclusions

- Buckbert, Deschutes, and Houstake soils in swales
- Stukel soils on ridges

Major Uses

Irrigated cropland (fig. 10), livestock grazing

Figure 10.—Irrigated pasture in an area of Redmond sandy loam, 0 to 3 percent slopes.

Major Management Limitations

Soil depth, surface texture, permeability, climate

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash,

reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth and risk of seepage.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice Flat 8-10pz

105C—Redmond-Deschutes-Stukel complex, 0 to 15 percent slopes

Composition

Redmond soil and similar inclusions—40 percent
Deschutes soil and similar inclusions—30 percent
Stukel soil and similar inclusions—20 percent
Contrasting inclusions—10 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Redmond and Deschutes soils—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread; Stukel soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Redmond Soil

0 to 12 inches—grayish brown sandy loam
12 to 21 inches—grayish brown loam
21 inches—basalt

Properties and Qualities of the Redmond Soil

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

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Typical Profile of the Stukel Soil

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Properties and Qualities of the Stukel Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

• Soils that have a gravelly substratum
• Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, permeability

General Management Considerations

• Care should be taken to protect the soils from wind erosion when applying range improvement practices.
• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth and risk of seepage.
• The restricted depth of the Stukel soil limits the choice of species for range seeding to drought-tolerant varieties.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Redmond and Deschutes soils—Pumice Flat 10-12pz
Stukel soil—Lava Blisters 10-12pz

106D—Redslide-Lickskillet complex, 15 to 30 percent north slopes

Composition

Redslide soil and similar inclusions—50 percent
Lickskillet soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Redslide soil—toe slopes; Lickskillet soil—upper slopes
Landform: Canyonsides
Parent material: Colluvium
Elevation: 2,000 to 4,000 feet
Native plants: Redslide soil—western juniper, antelope bitterbrush, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass; Lickskillet soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Redslide Soil

0 to 4 inches—grayish brown stony sandy loam
4 to 21 inches—brown very cobbly sandy loam
21 to 34 inches—brown extremely cobbly sandy loam
34 inches—fractured rhyolite

Properties and Qualities of the Redslide Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Contrasting Inclusions

- Soils that are deep sandy loam
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, rock fragments in surface layer, slope

General Management Considerations

- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Redslide soil—Sandy North 9-14pz
Lickskillet soil—Shallow North 9-12pz

106E—Redslide-Lickskillet complex, 30 to 50 percent north slopes

Composition

Redslide soil and similar inclusions—50 percent
Lickskillet soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Redslide soil—toe slopes; Lickskillet soil—upper slopes
Landform: Canyonsides
Parent material: Colluvium
Elevation: 2,000 to 4,000 feet
Native plants: Redslide soil—western juniper, antelope bitterbrush, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass; Lickskillet soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Redslide Soil

0 to 4 inches—grayish brown stony sandy loam
4 to 21 inches—brown very cobbly sandy loam
21 to 34 inches—brown extremely cobbly sandy loam
34 inches—fractured rhyolite

Properties and Qualities of the Redslide Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Lickskillet Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 14 inches—dark brown very cobbly sandy loam
14 inches—tuff

Properties and Qualities of the Lickskillet Soil

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 1 inch

Contrasting Inclusions

- Soils that are deep sandy loam
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, rock fragments in surface layer, slope

General Management Considerations

- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The restricted depth of the Lickskillet soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface and the steepness of slope.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and makes range seeding with ground equipment impractical.

Range Site

Redslide soil—Sandy North 9-14pz
Lickskillet soil—Shallow North 9-12pz

107B—Reluctan sandy loam, 1 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Residuum derived from basalt and welded tuff with ash on the surface
Elevation: 4,100 to 5,000 feet
Native plants: Stiff sagebrush, Sandberg bluegrass, bluebunch wheatgrass, bottlebrush squirreltail
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 4 inches—grayish brown sandy loam
4 to 10 inches—brown sandy loam
10 to 35 inches—brown and pale brown gravelly clay loam
35 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Shallow soils that have a duripan over bedrock
- Ninemile soils on lava plains
- Beden soils on lower toe slopes
- Swaler soils in basins
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Droughty Pumice 9-12pz

108C—Reluctan loam, 2 to 20 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Residuum derived from basalt and welded tuff
Elevation: 4,100 to 5,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass, basin big sagebrush, Thurber needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 10 inches—grayish brown loam
10 to 25 inches—brown clay loam
25 inches—basalt

Soil Properties and Qualities

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

Contrasting Inclusions

- Shallow soils that have a duripan over bedrock
- Beden soils on lower toe slopes
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Climate, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the soil depth and by the steepness of slope in some areas.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Droughty Loam 11-13pz

109—Rock outcrop

Composition

Rock outcrop—85 percent
Contrasting inclusions—15 percent

Setting

Slope: 20 to 65 percent
Elevation: 2,500 to 5,000 feet
Climatic factors:
Mean annual precipitation—10 to 15 inches
Mean annual air temperature—41 to 45 degrees F
Frost-free period—50 to 90 days

Description of Rock outcrop

Outcroppings of volcanic rock

Contrasting Inclusions

- Soils that have bedrock at a depth of 1 inch to 20 inches

Major Use

Wildlife habitat

110D—Schrier-Tub complex, 15 to 30 percent north slopes

Composition

Schrier soil and similar inclusions—45 percent
Tub soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Side slopes
Landform: Hills
Parent material: Loess over colluvium
Elevation: 2,600 to 4,500 feet
Native plants: Mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 14 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 130 days

Typical Profile of the Schrier Soil

0 to 16 inches—very dark grayish brown silt loam
16 to 21 inches—dark brown very gravelly silt loam
21 to 42 inches—dark brown silt loam
42 to 60 inches—dark brown extremely gravelly fine sand

Properties and Qualities of the Schrier Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 10 inches

Typical Profile of the Tub Soil

0 to 14 inches—dark grayish brown loam
14 to 24 inches—brown clay loam
24 to 28 inches—brown very cobbly clay
28 to 41 inches—brown cobbly clay
41 inches—rhyolite

Properties and Qualities of the Tub Soil

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 6 inches

Contrasting Inclusions

- Simas soils that are on side slopes and ridges and support low sagebrush
- Era soils in swales
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitation

Slope

General Management Considerations

- Pond development is limited by the steepness of slope.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Droughty North 9-12pz

110E—Schrier-Tub complex, 30 to 60 percent north slopes

Composition

Schrier soil and similar inclusions—45 percent
Tub soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Side slopes
Landform: Hills
Parent material: Loess over colluvium
Elevation: 2,600 to 4,500 feet
Native plants: Mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 14 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 130 days

Typical Profile of the Schrier Soil

0 to 16 inches—very dark grayish brown silt loam
16 to 21 inches—dark brown very gravelly silt loam
21 to 42 inches—dark brown silt loam
42 to 60 inches—dark brown extremely gravelly fine sand

Properties and Qualities of the Schrier Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 10 inches

Typical Profile of the Tub Soil

0 to 14 inches—dark grayish brown loam
14 to 24 inches—brown clay loam
24 to 28 inches—brown very cobbly clay
28 to 41 inches—brown cobbly clay
41 inches—rhyolite

Properties and Qualities of the Tub Soil

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 6 inches

Contrasting Inclusions

- Simas soils that are on side slopes and ridges and support low sagebrush
- Era soils in swales
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitation

Slope

General Management Considerations

- Pond development is limited by the steepness of slope.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.

Range Site

Droughty North 9-12pz

111D—Searles-Holmzie complex, 15 to 30 percent slopes

Composition

Searles soil and similar inclusions—50 percent
Holmzie soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash over residuum
Elevation: 3,000 to 3,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Searles Soil

0 to 7 inches—grayish brown sandy loam
7 to 13 inches—brown loam
13 to 24 inches—brown and yellowish brown very gravelly loam and very gravelly clay loam
24 inches—basalt

Properties and Qualities of the Searles Soil

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

Typical Profile of the Holmzie Soil

0 to 7 inches—dark grayish brown loam
7 to 19 inches—brown clay loam
19 to 29 inches—reddish brown gravelly clay
29 inches—weathered tuff

Properties and Qualities of the Holmzie Soil

Depth: Soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that are on ridges and have bedrock at a depth of 10 to 20 inches
- Soils that are in swales and have a clay or clay loam subsoil over a strongly cemented layer at a depth of 20 to 40 inches
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Searles and Holmzie soils—soil depth, climate, slope
Searles soil—surface texture

General Management Considerations

- Care should be taken to protect the Searles soil from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and steepness of slope.
- The low annual precipitation limits productivity and limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

South 9-12pz

112D—Searles-Holmzie complex, moist, 15 to 30 percent slopes

Composition

Searles soil and similar inclusions—50 percent
Holmzie soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash over residuum
Elevation: 3,500 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Searles Soil

0 to 7 inches—grayish brown sandy loam
7 to 13 inches—brown loam
13 to 24 inches—brown and yellowish brown very gravelly loam and very gravelly clay loam
24 inches—basalt

Properties and Qualities of the Searles Soil

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

Typical Profile of the Holmzie Soil

0 to 7 inches—dark grayish brown loam
7 to 19 inches—brown clay loam
19 to 29 inches—reddish brown gravelly clay
29 inches—weathered tuff

Properties and Qualities of the Holmzie Soil

Depth: Soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 5 inches

Contrasting Inclusions

- Soils that are on ridges and have bedrock at a depth of 10 to 20 inches
- Soils that have a stony or very stony surface layer
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Soil depth, slope

General Management Considerations

- Pond development is limited by the soil depth and steepness of slope.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pine-Juniper-Bitterbrush-Fescue

113C—Searles-Statz complex, 0 to 15 percent slopes

Composition

Searles soil and similar inclusions—45 percent
Statz soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Searles soil—ash over residuum; Statz soil—ash
Elevation: 2,000 to 4,000 feet
Native plants: Searles soil—Wyoming big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass; Statz soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Searles Soil

0 to 7 inches—grayish brown sandy loam
7 to 13 inches—brown loam
13 to 24 inches—brown and yellowish brown very gravelly loam and very gravelly clay loam
24 inches—basalt

Properties and Qualities of the Searles Soil

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

Typical Profile of the Statz Soil

0 to 14 inches—grayish brown sandy loam
14 to 20 inches—brown sandy loam
20 to 25 inches—indurated duripan
25 inches—basalt

Properties and Qualities of the Statz Soil

Depth: Duripan at a depth of 10 to 20 inches; bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Rock outcrop
- Lickskillet soils

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and the steepness of slope in some areas.
- The restricted depth to the duripan in the Statz soil

limits the choice of species for range seeding to drought-tolerant varieties.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Searles soil—Droughty 8-12pz
Statz soil—Lava Blisters 10-12pz

114C—Shanahan loamy coarse sand, 0 to 15 percent slopes

Composition

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

Setting

Landform: Pumice-mantled lava plains
Parent material: Ash over old alluvium
Elevation: 4,500 to 6,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 8 inches—brown loamy coarse sand
8 to 26 inches—very pale brown and light yellowish brown gravelly loamy coarse sand, loamy coarse sand, and coarse sand
26 to 44 inches—brown and yellowish brown sandy loam and gravelly sandy loam
44 to 61 inches—very dark gray very gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 7 inches

Contrasting Inclusions

• Sunriver soils in depressions
• Cryaquolls in depressions
• Steiger soils south of LaPine

Major Use

Woodland

Major Management Limitations

Rooting depth, surface texture, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-11

114D—Shanahan loamy coarse sand, 15 to 30 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash over colluvium
Elevation: 4,500 to 6,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 8 inches—brown loamy coarse sand
8 to 26 inches—very pale brown and light yellowish

brown gravelly loamy coarse sand, loamy coarse sand, and coarse sand
26 to 61 inches—brown and yellowish brown sandy loam and gravelly sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

- Sunriver soils in depressions
- Steiger soils south of LaPine

Major Use

Woodland

Major Management Limitations

Rooting depth, slope, surface texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-11

115A—Shanahan loamy coarse sand, low, 0 to 3 percent slopes

Composition

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

Setting

Landscape position: Depressions
Landform: Pumice-mantled lava plains
Parent material: Ash over old alluvium
Elevation: 4,000 to 4,500 feet
Native plants: Lodgepole pine, antelope bitterbrush, and Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 30 days

Typical Profile

1 inch to 0—organic mat
0 to 8 inches—brown loamy coarse sand
8 to 26 inches—very pale brown and light yellowish brown loamy coarse sand and coarse sand
26 to 44 inches—brown and yellowish brown sandy loam and gravelly sandy loam
44 to 61 inches—very dark gray very gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 7 inches

Contrasting Inclusions

- Sunriver soils in depressions
- Cryaquolls in depressions
- Steiger soils south of LaPine

Major Use

Woodland

Major Management Limitations

Frost heaving, rooting depth, surface texture, low fertility, susceptibility to compaction

General Management Considerations

- Severe frost or frost heaving can damage or kill seedlings.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.

• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CL-S2-14

116E—Shroyton loamy sand, 30 to 50 percent slopes

Composition

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

Setting

Landform: Mountains
Parent material: Ash
Elevation: 4,500 to 6,400 feet
Native plants: Ponderosa pine, Douglas fir, white fir, common snowberry, pinegrass
Climatic factors:
Mean annual precipitation—30 to 50 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 15 inches—brown loamy sand
15 to 31 inches—brown gravelly coarse sandy loam
31 to 55 inches—yellowish brown gravelly sandy loam
55 inches—andesite

Soil Properties and Qualities

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Rapid
Available water capacity: About 6 inches

Contrasting Inclusions

• Sisters and Yapoah soils at lower elevations
• Soils that have a very gravelly or very cobbly subsoil
• Rock outcrop

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-14

117C—Simas silt loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Hills
Parent material: Loess over colluvium
Elevation: 2,600 to 3,500 feet
Native plants: Western juniper, low sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—9 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 140 days

Typical Profile

0 to 5 inches—dark grayish brown silt loam
5 to 21 inches—dark grayish brown cobbly clay
21 to 60 inches—yellowish brown gravelly clay

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 7 inches

Contrasting Inclusions

• Soils that do not have an abrupt clay increase in the subsoil

Major Use

Livestock grazing

Major Management Limitation

Depth to claypan

General Management Considerations

• Shallow rooting depth limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Droughty Claypan 10-12pz

118D—Simas-Ruckles complex, 15 to 40 percent north slopes

Composition

Simas soil and similar inclusions—50 percent
Ruckles soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Simas soil—toe slopes; Ruckles soil—midslopes
Landform: Canyons
Parent material: Colluvium
Elevation: 1,400 to 2,600 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 140

Typical Profile of the Simas Soil

0 to 12 inches—dark grayish brown cobbly loam
12 to 37 inches—dark grayish brown and brown cobbly clay and clay
37 to 60 inches—yellowish brown gravelly clay

Properties and Qualities of the Simas Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 7 inches

Typical Profile of the Ruckles Soil

0 to 9 inches—dark grayish brown extremely cobbly loam
9 to 14 inches—brown extremely cobbly clay loam
14 to 18 inches—light yellowish brown cobbly clay
18 to 19 inches—weathered tuff
19 inches—welded tuff

Properties and Qualities of the Ruckles Soil

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

Contrasting Inclusions

• Soils that are similar to the Simas soil but are more than 35 percent rock fragments throughout
• Very shallow soils associated with exposed bedrock

Major Use

Livestock grazing

Major Management Limitations

Simas and Ruckles soils—rock fragments in surface layer, slope
Ruckles soil—soil depth, available water capacity

General Management Considerations

• Pond development is limited by the steepness of slope.
• The low available water capacity and the restricted depth of the Ruckles soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is limited by the rock fragments on the surface.
• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.

Range Site

Droughty North 9-12pz

119D—Simas-Ruckles complex, 15 to 40 percent south slopes

Composition

Simas soil and similar inclusions—50 percent
Ruckles soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Simas soil—toe slopes; Ruckles soil—midslopes
Landform: Canyons
Parent material: Colluvium
Elevation: 1,400 to 2,600 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Simas Soil

0 to 12 inches—dark grayish brown cobbly loam
12 to 37 inches—dark grayish brown and brown cobbly clay and clay
37 to 60 inches—yellowish brown gravelly clay

Properties and Qualities of the Simas Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 7 inches

Typical Profile of the Ruckles Soil

0 to 9 inches—dark grayish brown extremely cobbly loam
9 to 14 inches—brown extremely cobbly clay loam
14 to 18 inches—light yellowish brown cobbly clay
18 to 19 inches—weathered tuff
19 inches—welded tuff

Properties and Qualities of the Ruckles Soil

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

Contrasting Inclusions

- Soils that are similar to the Simas soil but are more than 35 percent rock fragments throughout
- Very shallow soils associated with exposed bedrock

Major Use

Livestock grazing

Major Management Limitations

Simas and Ruckles soils—rock fragments in surface layer, slope, aspect
Ruckles soil—soil depth, available water capacity

General Management Considerations

- Pond development is limited by the steepness of slope.
- The low available water capacity and the restricted depth of the Ruckles soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is limited by the rock fragments on the surface.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
- The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

Droughty South 9-12pz

120F—Simas-Ruckles-Rock outcrop complex, 40 to 80 percent north slopes

Composition

Simas soil and similar inclusions—50 percent
Ruckles soil and similar inclusions—35 percent
Rock outcrop—10 percent
Contrasting inclusions—5 percent

Setting

Landscape position: Simas soil—toe slopes; Ruckles soil—midslopes; Rock outcrop—upper slopes
Landform: Canyons
Parent material: Colluvium
Elevation: 1,400 to 2,600 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—110 to 140

Typical Profile of the Simas Soil

0 to 12 inches—dark grayish brown cobbly loam

12 to 37 inches—dark grayish brown and brown cobbly clay and clay
37 to 60 inches—yellowish brown gravelly clay

Properties and Qualities of the Simas Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 7 inches

Typical Profile of the Ruckles Soil

0 to 9 inches—dark grayish brown extremely cobbly loam
9 to 14 inches—brown extremely cobbly clay loam
14 to 18 inches—light yellowish brown cobbly clay
18 to 19 inches—weathered tuff
19 inches—welded tuff

Properties and Qualities of the Ruckles Soil

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

Contrasting Inclusions

- Soils that are similar to the Simas soil but are more than 35 percent rock fragments throughout
- Very shallow soils associated with exposed bedrock

Major Use

Livestock grazing

Major Management Limitations

Simas and Ruckles soils—Rock outcrop, rock fragments in surface layer, slope
Ruckles soil—soil depth, available water capacity

General Management Considerations

- Pond development is limited by the steepness of slope.
- The low available water capacity and the restricted depth of the Ruckles soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Droughty North 9-12pz

121F—Simas-Ruckles-Rock outcrop complex, 40 to 80 percent south slopes

Composition

Simas soil and similar inclusions—50 percent
Ruckles soil and similar inclusions—35 percent
Rock outcrop—10 percent
Contrasting inclusions—5 percent

Setting

Landscape position: Simas soil—toe slopes; Ruckles soil—midslopes; Rock outcrop—upper slopes
Landform: Canyons
Parent material: Colluvium
Elevation: 1,400 to 2,600 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Typical Profile of the Simas Soil

0 to 12 inches—dark grayish brown cobbly loam
12 to 37 inches—dark grayish brown and brown cobbly clay and clay
37 to 60 inches—yellowish brown gravelly clay

Properties and Qualities of the Simas Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 7 inches

Typical Profile of the Ruckles Soil

0 to 9 inches—dark grayish brown extremely cobbly loam
9 to 14 inches—brown extremely cobbly clay loam
14 to 18 inches—light yellowish brown cobbly clay
18 to 19 inches—weathered tuff
19 inches—welded tuff

Properties and Qualities of the Ruckles Soil

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

Contrasting Inclusions

- Soils that are similar to the Simas soil but are more than 35 percent rock fragments throughout

• Very shallow soils associated with exposed bedrock

Major Use

Livestock grazing

Major Management Limitations

Simas and Ruckles soils—Rock outcrop, rock fragments in surface layer, slope, aspect
Ruckles soil—soil depth, available water capacity

General Management Considerations

• Pond development is limited by the steepness of slope.
• The low available water capacity and the restricted depth of the Ruckles soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• The steepness of slope restricts livestock distribution and restricts range seeding with ground equipment.
• The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.
• The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Droughty South 9-12pz

122C—Sisters loamy sand, 0 to 15 percent slopes

Composition

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

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 3,200 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile

2 inches to 0—organic mat
0 to 23 inches—dark brown and dark yellowish brown loamy sand
23 to 35 inches—dark brown sandy loam
35 to 60 inches—dark reddish brown and dark brown clay loam and loam

Soil Properties and Qualities

Depth: Colluvium at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Rapid over moderately slow
Available water capacity: About 8 inches

Contrasting Inclusions

• Fryrear and Wanoga soils on side slopes and ridges
• Yapoah soils on side slopes
• Rock outcrop

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-17

123C—Sisters-Yapoah complex, 0 to 15 percent slopes

Composition

Sisters soil and similar inclusions—50 percent
Yapoah soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Sisters soil—ash over colluvium and residuum; Yapoah soil—ash and colluvium
Elevation: 3,200 to 5,000 feet

Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Sisters Soil

2 inches to 0—organic mat
0 to 23 inches—dark brown and dark yellowish brown loamy sand
23 to 35 inches—dark brown sandy loam
35 to 60 inches—dark reddish brown and dark brown clay loam and loam

Properties and Qualities of the Sisters Soil

Depth: Colluvium at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Rapid over moderately slow
Available water capacity: About 8 inches

Typical Profile of the Yapoah Soil

2 inches to 0—organic mat
0 to 12 inches—dark brown very cobbly loamy sand
12 to 60 inches—dark yellowish brown extremely flaggy loamy sand

Properties and Qualities of the Yapoah Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Fryrear soils on side slopes and ridges
- Wanoga soils on side slopes
- Rock outcrop

Major Use

Woodland

Major Management Limitations

Sisters soil—low fertility, susceptibility to compaction
Yapoah soil—rock fragments, available water capacity

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Because of the low fertility of the subsoil in the Sisters soil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility of the Sisters soil to compaction, designated skid trails should be used.
- Seedlings on the Yapoah soil have a poor survival rate because of the low available water capacity.
- Rock fragments in the Yapoah soil restrict the planting of seedlings.

Forest Service Plant Association

CP-S2-17

123D—Sisters-Yapoah complex, 15 to 30 percent slopes

Composition

Sisters soil and similar inclusions—50 percent
Yapoah soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Sisters soil—ash over colluvium and residuum; Yapoah soil—ash and colluvium
Elevation: 3,200 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Sisters Soil

2 inches to 0—organic mat
0 to 23 inches—dark brown and dark yellowish brown loamy sand
23 to 35 inches—dark brown sandy loam
35 to 60 inches—dark reddish brown and dark brown clay loam and loam

Properties and Qualities of the Sisters Soil

Depth: Colluvium at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained

Permeability: Rapid over moderately slow
Available water capacity: About 8 inches

Typical Profile of the Yapoah Soil

2 inches to 0—organic mat
0 to 12 inches—dark brown very cobbly loamy sand
12 to 60 inches—dark yellowish brown extremely flaggy loamy sand

Properties and Qualities of the Yapoah Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Fryrear soils on side slopes and ridges
- Wanoga soils on side slopes
- Rock outcrop

Major Use

Woodland

Major Management Limitations

Sisters soil—slope, low fertility, susceptibility to compaction
Yapoah soil—slope, rock fragments, available water capacity

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil in the Sisters soil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility of the Sisters soil to compaction, designated skid trails should be used.
- Seedlings on the Yapoah soil have a poor survival rate because of the low available water capacity.
- Rock fragments in the Yapoah soil restrict the planting of seedlings.

Forest Service Plant Association

CP-S2-17

123E—Sisters-Yapoah complex, 30 to 50 percent slopes

Composition

Sisters soil and similar inclusions—50 percent
Yapoah soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Sisters soil—ash over colluvium and residuum; Yapoah soil—ash and colluvium
Elevation: 3,200 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Sisters Soil

2 inches to 0—organic mat
0 to 23 inches—dark brown and dark yellowish brown loamy sand
23 to 35 inches—dark brown sandy loam
35 to 60 inches—dark reddish brown and dark brown clay loam and loam

Properties and Qualities of the Sisters Soil

Depth: Colluvium at a depth of 20 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Rapid over moderately slow
Available water capacity: About 8 inches

Typical Profile of the Yapoah Soil

2 inches to 0—organic mat
0 to 12 inches—dark brown very cobbly loamy sand

12 to 60 inches—dark yellowish brown extremely flaggy loamy sand

Properties and Qualities of the Yapoah Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Fryrear soils on side slopes and ridges
- Wanoga soils on side slopes
- Rock outcrop

Major Use

Woodland

Major Management Limitations

Sisters soil—slope, low fertility, susceptibility to compaction
Yapoah soil—slope, rock fragments, available water capacity

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the susceptibility to compaction, all ground operations, including tractor skidding, mechanical harvesting, and machine piling, should be avoided unless the surface layer is frozen or covered with snow. Subsoiling can be used to loosen the compacted layer.
- Because of the moderate susceptibility of the Sisters soil to compaction, designated skid trails should be used.
- Seedlings on the Yapoah soil have a poor survival rate because of the low available water capacity.
- Rock fragments in the Yapoah soil restrict the planting of seedlings.

Forest Service Plant Association

CP-S2-17

124C—Smiling sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 40 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Soil Properties and Qualities

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 40 to 60 inches
- Windego soils on side slopes

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.

• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-17

125D—Smiling-Windego complex, 15 to 30 percent slopes

Composition

Smiling soil and similar inclusions—50 percent
Windego soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 2,500 to 3,500 feet
Native plants: Smiling soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue; Windego soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses
Climatic factors:
Mean annual precipitation—20 to 40 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Contrasting Inclusions

• Soils that have bedrock at a depth of 20 to 40 inches
• Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Smiling soil—CP-S2-17
Windego soil—CP-S2-13

126C—Smiling-Windego complex, cool, 0 to 15 percent slopes

Composition

Smiling soil and similar inclusions—65 percent
Windego soil and similar inclusions—25 percent
Contrasting inclusions—10 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 3,500 to 4,000 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush, chinkapin, brackenfern
Climatic factors:
Mean annual precipitation—30 to 50 inches
Mean annual air temperature—40 to 45 degrees F
Frost-free period—50 to 70 days

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Rock outcrop on ridges
- Bott soils on ridges

Major Use

Woodland

Major Management Limitations

Low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-C2-11

126D—Smiling-Windego complex, cool, 15 to 30 percent slopes

Composition

Smiling soil and similar inclusions—65 percent
Windego soil and similar inclusions—25 percent
Contrasting inclusions—10 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 3,500 to 4,000 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush, chinkapin, brackenfern
Climatic factors:
Mean annual precipitation—30 to 50 inches
Mean annual air temperature—40 to 45 degrees F
Frost-free period—50 to 70 days

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained

Permeability: Moderate
Available water capacity: About 6 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Rock outcrop on ridges
- Bott soils on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-C2-11

127A—Statz sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 14 inches—grayish brown sandy loam
14 to 20 inches—brown sandy loam
20 to 25 inches—indurated duripan
25 inches—basalt

Soil Properties and Qualities

Depth: Duripan at a depth of 10 to 20 inches; bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Houstake, Deschutes, and Redmond soils in swales
- Rock outcrop

Major Uses

Livestock grazing, irrigated cropland

Major Management Limitations

Surface texture, soil depth, permeability, available water capacity

General Management Considerations

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The restricted soil depth limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Irrigated cropland

- Because of the restricted soil depth and the low available water capacity, intensive irrigation water management is needed for crop production.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

• The included areas of Rock outcrop limit the areas suitable for crops and restrict farming operations.

Range Site

Lava Blisters 10-12pz

128C—Statz-Deschutes complex, 0 to 15 percent slopes

Composition

Statz soil and similar inclusions—45 percent
Deschutes soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Statz soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue; Deschutes soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Statz Soil

0 to 14 inches—grayish brown sandy loam
14 to 20 inches—brown sandy loam
20 to 25 inches—indurated duripan
25 inches—basalt

Properties and Qualities of the Statz Soil

Depth: Duripan at a depth of 10 to 20 inches; bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 2 inches

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Contrasting Inclusions

• Redmond soils in swales
• Stukel soils on ridges

Major Use

Livestock grazing

Major Management Limitations

Statz and Deschutes soils—surface texture, soil depth
Deschutes soil—permeability

General Management Considerations

• Care should be taken to protect the soils from wind erosion when applying range improvement practices.
• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth, the risk of seepage in the Deschutes soil, and the steepness of slope in some areas.
• The restricted depth of the Statz soil limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Statz soil—Lava Blisters 10-12pz
Deschutes soil—Pumice Flat 10-12pz

128D—Statz-Deschutes complex, 15 to 30 percent slopes

Composition

Statz soil and similar inclusions—45 percent
Deschutes soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Statz soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass; Deschutes soil—western juniper, antelope bitterbrush, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Statz Soil

0 to 14 inches—grayish brown sandy loam

14 to 20 inches—brown sandy loam
20 to 25 inches—indurated duripan
25 inches—basalt

Properties and Qualities of the Statz Soil

Depth: Duripan at a depth of 10 to 20 inches; bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Contrasting Inclusions

- Redmond soils in swales
- Stukel soils on ridges

Major Use

Livestock grazing

Major Management Limitations

Statz and Deschutes soils—surface texture, soil depth
Deschutes soil—permeability

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, the risk of seepage in the Deschutes soil, and the steepness of slope.
- The restricted depth of the Statz soil limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Statz soil—Shallow North 9-12pz
Deschutes soil—Sandy North 9-14pz

129C—Steiger loamy coarse sand, 0 to 15 percent slopes

Composition

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

Setting

Landform: Pumice-mantled lava plains
Parent material: Ash and pumice over colluvium and old alluvium
Elevation: 4,200 to 4,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, needlegrasses
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—20 to 50 days

Typical Profile

3 inches to 0—organic mat
0 to 2 inches—dark grayish brown loamy coarse sand
2 to 18 inches—dark brown gravelly coarse sand
18 to 28 inches—light brownish gray very gravelly coarse sand
28 to 49 inches—pale yellow gravelly coarse sand
49 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Depth: Colluvium at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 11 inches

Contrasting Inclusions

- Shanahan soils north of LaPine
- Tutni soils in depressions
- Poorly drained soils in depressions

Major Use

Woodland

Major Management Limitations

Soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.

• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-12

130C—Steiger loamy coarse sand, high elevation, 3 to 15 percent slopes

Composition

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

Setting

Landform: Pumice-mantled lava plains
Parent material: Ash and pumice over colluvium and old alluvium
Elevation: 4,500 to 6,000 feet
Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, manzanita
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

3 inches to 0—organic mat
0 to 2 inches—dark grayish brown loamy coarse sand
2 to 18 inches—dark brown gravelly coarse sand
18 to 28 inches—light brownish gray very gravelly coarse sand
28 to 49 inches—pale yellow gravelly coarse sand
49 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Depth: Colluvium at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 11 inches

Contrasting Inclusions

• Shanahan soils north of LaPine

Major Use

Woodland

Major Management Limitations

Soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-S1-12

130D—Steiger loamy coarse sand, high elevation, 15 to 30 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash and pumice over colluvium
Elevation: 4,500 to 6,000 feet
Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, manzanita
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

3 inches to 0—organic mat
0 to 2 inches—dark grayish brown loamy coarse sand

2 to 18 inches—dark brown gravelly coarse sand
18 to 28 inches—light brownish gray very gravelly coarse sand
28 to 49 inches—pale yellow gravelly coarse sand
49 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Depth: Colluvium at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 11 inches

Contrasting Inclusions

- Shanahan soils north of LaPine

Major Use

Woodland

Major Management Limitations

Soil depth, slope, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Using machinery only in areas covered with logging slash or brush reduces soil displacement.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-S1-12

130E—Steiger loamy coarse sand, high elevation, 30 to 50 percent slopes

Composition

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

Setting

Landform: Pumice-mantled hills
Parent material: Ash and pumice over colluvium
Elevation: 4,500 to 6,000 feet
Native plants: Ponderosa pine, white fir, Douglas fir, snowbrush, manzanita
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 40 days

Typical Profile

3 inches to 0—organic mat
0 to 2 inches—dark grayish brown loamy coarse sand
2 to 18 inches—dark brown gravelly coarse sand
18 to 28 inches—light brownish gray very gravelly coarse sand
28 to 49 inches—pale yellow gravelly coarse sand
49 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Depth: Colluvium at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 11 inches

Contrasting Inclusions

- Shanahan soils north of LaPine

Major Use

Woodland

Major Management Limitations

Soil depth, slope, soil texture, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical

treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Restrict the use of prescribed burning to periods when logging slash or natural fuel has a moderate to high moisture content or consider alternative disposal techniques.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-S1-12

131A—Steiger loamy coarse sand, low, 0 to 3 percent slopes

Composition

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

Setting

Landscape position: Depressions
Landform: Pumice-mantled lava plains
Parent material: Ash and pumice over old alluvium and colluvium
Elevation: 4,200 to 4,500 feet
Native plants: Lodgepole pine, antelope bitterbrush, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 30 days

Typical Profile

3 inches to 0—organic mat
0 to 2 inches—dark grayish brown loamy coarse sand
2 to 18 inches—dark brown gravelly coarse sand
18 to 28 inches—light brownish gray very gravelly coarse sand
28 to 49 inches—pale yellow gravelly coarse sand
49 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Depth: Old alluvium at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderate
Available water capacity: About 11 inches

Contrasting Inclusions

• Shanahan soils north of LaPine
• Tutni soils in depressions
• Poorly drained soils in depressions

Major Use

Woodland

Major Management Limitations

Frost heaving, soil depth, soil texture, low fertility, susceptibility to compaction

General Management Considerations

• Severe frost or frost heaving can damage or kill seedlings.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CL-S2-14

132A—Stookmoor loamy sand, 1 to 3 percent slopes

Composition

Stookmoor soil and similar inclusions—85 percent

Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 4,300 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 6 inches—grayish brown loamy sand
6 to 24 inches—grayish brown and pale brown sandy loam
24 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Ninemile and Dester soils on lava plains
- Choptie soils on knolls
- Gardone soils on toe slopes
- Borobey soils along drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice 8-10pz

133A—Stookmoor gravelly loamy sand, 1 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 4,300 to 4,800 feet
Native plants: Mountain big sagebrush, western needlegrass, Ross sedge, bottlebrush squirreltail
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 6 inches—grayish brown gravelly loamy sand
6 to 24 inches—grayish brown and pale brown sandy loam
24 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

- Ninemile and Dester soils on lava plains
- Choptie soils on knolls
- Gardone soils toe slopes
- Borobey soils along drainageways

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.

• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Range Site

Pumice Flat 9-11pz

134D—Stookmoor gravelly loamy sand, 20 to 50 percent north slopes

Composition

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

Setting

Landscape position: Side slopes
Landform: Hills
Parent material: Ash
Elevation: 4,300 to 4,800 feet
Native plants: Western juniper, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 6 inches—grayish brown gravelly loamy sand
6 to 24 inches—grayish brown and pale brown sandy loam
24 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderately slow
Available water capacity: About 4 inches

Contrasting Inclusions

• Choptie soils on knolls and hills
• Gardone soils on toe slopes
• Westbutte soils on steep hillsides
• Redcliff soils along drainageways of rocky ravines

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth, permeability, slope

General Management Considerations

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
• The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.

Range Site

Pumice North 9-12pz

135C—Stookmoor-Beden complex, 1 to 20 percent slopes

Composition

Stookmoor soil and similar inclusions—45 percent
Beden soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Stookmoor soil—ash; Beden soil—residuum derived from basalt with ash on the surface
Elevation: 4,300 to 4,800 feet
Native plants: Stookmoor soil—mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass; Beden soil—western juniper, mountain big sagebrush, Idaho fescue, Thurber needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Stookmoor Soil

0 to 6 inches—grayish brown loamy sand
6 to 24 inches—grayish brown and pale brown sandy loam
24 inches—basalt

Properties and Qualities of the Stookmoor Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderately slow
Available water capacity: About 4 inches

Typical Profile of the Beden Soil

0 to 11 inches—grayish brown and brown sandy loam
11 to 15 inches—brown loam
15 to 18 inches—brown clay loam
18 inches—basalt

Properties and Qualities of the Beden Soil

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

Contrasting Inclusions

- Borobey soils in small basins and along narrow drainageways
- Gardone soils on toe slopes
- Dester soils on lava plains
- Rock outcrop on basalt pressure ridges

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and by the steepness of slope in some areas.
- The low annual precipitation and the restricted depth of the Beden soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Stookmoor soil—Pumice 8-10pz
Beden soil—Shallow Pumice Hills 9-11pz

136C—Stookmoor-Gardone-Rock outcrop complex, 1 to 15 percent slopes

Composition

Stookmoor soil and similar inclusions—45 percent
Gardone soil and similar inclusions—35 percent
Rock outcrop—10 percent
Contrasting inclusions—10 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 4,300 to 4,800 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, western needlegrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Stookmoor Soil

0 to 6 inches—grayish brown loamy sand
6 to 24 inches—grayish brown and pale brown sandy loam
24 inches—basalt

Properties and Qualities of the Stookmoor Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderately slow
Available water capacity: About 4 inches

Typical Profile of the Gardone Soil

0 to 10 inches—dark grayish brown sand
10 to 60 inches—grayish brown and pale brown loamy sand

Properties and Qualities of the Gardone Soil

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

Contrasting Inclusions

- Borobey soils in small basins and along narrow drainageways

- Moderately deep and deep ash deposits over a buried soil
- Blayden soils on terraces

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, climate, surface texture, soil depth, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, the risk of seepage, and the steepness of slope in some areas.
- The low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice 8-10pz

137E—Stookmoor-Westbutte complex, 25 to 50 percent north slopes

Composition

Stookmoor soil and similar inclusions—45 percent
Westbutte soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing slopes
Landform: Hills
Parent material: Stookmoor soil—ash; Westbutte soil—colluvium derived from basalt or tuff with ash on the surface
Elevation: 4,300 to 4,800 feet
Native plants: Western juniper, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Stookmoor Soil

0 to 6 inches—grayish brown loamy sand
6 to 24 inches—grayish brown and pale brown sandy loam
24 inches—basalt

Properties and Qualities of the Stookmoor Soil

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Somewhat excessively drained
Permeability: Rapid over moderately slow
Available water capacity: About 4 inches

Typical Profile of the Westbutte Soil

0 to 9 inches—very dark grayish brown stony loam
9 to 21 inches—dark brown very cobbly loam
21 to 30 inches—brown very cobbly clay loam
30 inches—welded tuff

Properties and Qualities of the Westbutte Soil

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

Contrasting Inclusions

- Menbo soils on ridges
- Choptie soils near areas of Rock outcrop
- Rock outcrop that occurs as ridges of basalt or welded tuff
- Gardone soils

Major Use

Livestock grazing

Major Management Limitations

Climate, surface texture, soil depth, permeability, rock fragments in surface layer, slope

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the Stookmoor soil from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The low annual precipitation and the restricted soil depth limit productivity and limit the choice of species

for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is limited by the rock fragments on the surface of the Westbutte soil.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.

Range Site

Pumice North 9-12pz

138A—Stukel sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

• Deschutes and Houstake soils in swales
• Soils that have a loamy sand surface layer
• Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth

General Management Considerations

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth.
• The restricted soil depth limits the choice of species for range seeding to drought-tolerant varieties.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Lava Blisters 10-12pz

138B—Stukel sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

• Deschutes and Houstake soils in swales

- Soils that have a loamy sand surface layer
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth

General Management Considerations

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The restricted soil depth limits the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Lava Blisters 10-12pz

139A—Stukel sandy loam, dry, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Deschutes and Houstake soils in swales
- Soils that have a loamy sand surface layer
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, climate

General Management Considerations

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Lava Blisters 8-10pz

139B—Stukel sandy loam, dry, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam

11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Deschutes and Houstake soils in swales
- Soils that have a loamy sand surface layer
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, climate

General Management Considerations

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth.
- The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Lava Blisters 8-10pz

140B—Stukel-Deschutes complex, dry, 0 to 8 percent slopes

Composition

Stukel soil and similar inclusions—50 percent
Deschutes soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Stukel soil—western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass; Deschutes soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile of the Stukel Soil

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Properties and Qualities of the Stukel Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Contrasting Inclusions

- Redmond soils in swales
- Soils that have a loamy sand surface layer
- Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, soil depth, permeability, climate

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development on these soils is limited by the soil depth and risk of seepage.
- The low annual precipitation and restricted depth of the Stukel soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The included areas of Rock outcrop limit the areas

suitable for grazing and restrict accessibility by livestock.

Range Site

Stukel soil—Lava Blisters 8-10pz
Deschutes soil—Pumice Flat 8-10pz

141C—Stukel-Deschutes-Rock outcrop complex, 0 to 15 percent slopes

Composition

Stukel soil and similar inclusions—40 percent
Deschutes soil and similar inclusions—25 percent
Rock outcrop—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 4,000 feet
Native plants: Stukel soil—western juniper, mountain big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Idaho fescue; Deschutes soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 50 degrees F
Frost-free period—70 to 90 days

Typical Profile of the Stukel Soil

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Properties and Qualities of the Stukel Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Contrasting Inclusions

- Redmond soils in swales

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, surface texture, soil depth, permeability

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, the risk of seepage, and the steepness of slope in some areas.
- The restricted depth of the Stukel soil limits the choice of species for range seeding to drought-tolerant varieties.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Stukel soil—Lava Blisters 10-12pz
Deschutes soil—Pumice Flat 10-12pz

142B—Stukel-Rock outcrop-Deschutes complex, dry, 0 to 8 percent slopes

Composition

Stukel soil and similar inclusions—35 percent
Rock outcrop—30 percent
Deschutes soil and similar inclusions—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Lava plains
Parent material: Ash
Elevation: 2,500 to 3,500 feet
Native plants: Stukel soil—western juniper, mountain big sagebrush, bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass; Deschutes soil—western juniper, mountain big sagebrush, needleandthread, Idaho fescue, western needlegrass
Climatic factors:

Mean annual precipitation—8 to 10 inches
Mean annual air temperature—49 to 52 degrees F
Frost-free period—80 to 100 days

Typical Profile of the Stukel Soil

0 to 4 inches—grayish brown sandy loam
4 to 11 inches—brown cobbly sandy loam
11 to 18 inches—pale brown gravelly sandy loam
18 inches—basalt

Properties and Qualities of the Stukel Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Deschutes Soil

0 to 17 inches—grayish brown sandy loam
17 to 31 inches—light grayish brown sandy loam
31 inches—basalt

Properties and Qualities of the Deschutes Soil

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

Contrasting Inclusions

- Redmond and Houstake soils in swales

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, surface texture, soil depth, permeability, climate

General Management Considerations

- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.
- The low annual precipitation and the restricted depth of the Stukel soil limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
- The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Stukel soil—Lava Blisters 8-10pz
Deschutes soil—Pumice Flat 8-10pz

143B—Suilotem-Circle complex, 0 to 8 percent slopes

Composition

Suilotem soil and similar inclusions—50 percent
Circle soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 2,500 to 3,500 feet
Native plants: Suilotem soil—ponderosa pine, white fir, common snowberry, twinflower; Circle soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 35 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Suilotem Soil

1 inch to 0—organic mat
0 to 27 inches—dark brown sandy loam
27 to 51 inches—very dark brown and black fine sandy loam and loamy fine sand
51 to 60 inches—dark brown very fine sandy loam

Properties and Qualities of the Suilotem Soil

Depth: Glacial outwash at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: At the surface to a depth of 24 inches below the surface in April through June
Permeability: Moderately rapid
Available water capacity: About 8 inches

Typical Profile of the Circle Soil

1 inch to 0—organic mat
0 to 16 inches—dark brown sandy loam
16 to 42 inches—dark brown and dark yellowish brown loam and gravelly loam
42 to 65 inches—dark yellowish brown very gravelly clay loam

Properties and Qualities of the Circle Soil

Depth: Glacial outwash at a depth of 40 to 50 inches;

bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 9 inches

Contrasting Inclusions

- Allingham soils in higher positions
- Suttle and Wizard soils in swales
- Poorly drained soils in swales

Major Use

Woodland

Major Management Limitations

Suilotem and Circle soils—low fertility, susceptibility to compaction
Suilotem soil—wetness

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- The seasonal high water table in the Suilotem soil restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Suilotem soil—CD-S6-12
Circle soil—CP-S2-17

144A—Sunriver sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Stream terraces
Parent material: Ash over old alluvium
Elevation: 4,000 to 4,300 feet
Native plants: Lodgepole pine, blueberry, forbs
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

2 inches to 0—organic mat
0 to 5 inches—very dark gray sandy loam
5 to 20 inches—dark gray loamy coarse sand
20 to 29 inches—light brownish gray coarse sand
29 to 60 inches—very dark gray sandy loam

Soil Properties and Qualities

Depth: Old alluvium at a depth of 25 to 35 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: 24 to 48 inches below the surface in April through June
Permeability: Moderately rapid
Available water capacity: About 7 inches

Contrasting Inclusions

- Cryaquolls adjacent to streams and rivers
- Well drained and moderately well drained soils in slightly higher areas

Major Use

Woodland

Major Management Limitations

Soil depth, wetness, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because this coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- The seasonal high water table restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CL-M3-11

145C—Suttle very gravelly loamy sand, 0 to 15 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash and scoria over glacial outwash
Elevation: 3,000 to 3,500 feet
Native plants: Ponderosa pine, white fir, common snowberry, twinflower
Climatic factors:
Mean annual precipitation—30 to 40 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile

1 inch to 0—organic mat
0 to 10 inches—black very gravelly loamy sand
10 to 22 inches—black and dark brown very gravelly coarse sand
22 to 37 inches—dark brown and black gravelly sandy loam and loamy fine sand
37 to 60 inches—dark brown sandy loam

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: At the surface to a depth of 24 inches below the surface in April through June
Permeability: Very rapid over moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Allingham and Circle soils on outwash plains in slightly higher positions
- Suilotem soils in swales and channels
- Poorly drained soils in swales

Major Use

Woodland

Major Management Limitation

Surface texture

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Because the surface layer is coarse textured, the available water capacity is low and the seedling mortality rate is severe.

Forest Service Plant Association

CD-S6-12

146C—Suttle very gravelly loamy sand, dry, 0 to 15 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash and scoria over glacial outwash
Elevation: 2,500 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile

1 inch to 0—organic mat
0 to 10 inches—black very gravelly loamy sand
10 to 22 inches—black and dark brown very gravelly coarse sand
22 to 37 inches—dark brown and black gravelly sandy loam and loamy fine sand
37 to 60 inches—dark brown sandy loam

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 20 to 30 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: At the surface to a depth of 24 inches below the surface in April through June
Permeability: Very rapid over moderately rapid
Available water capacity: About 5 inches

Contrasting Inclusions

- Allingham and Circle soils on outwash plains in slightly higher positions
- Suilotem soils in swales and channels

Major Use

Woodland

Major Management Limitation

Surface texture

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Because the surface layer is coarse textured, the available water capacity is low and the seedling mortality rate is severe.

Forest Service Plant Association

CP-S2-17

147A—Swaler gravelly coarse sand, 0 to 2 percent slopes

Composition

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

Setting

Landform: Lake terraces
Parent material: Lacustrine sediment with ash on the surface
Elevation: 4,100 to 4,600 feet
Native plants: Mountain big sagebrush, western needlegrass, Ross sedge, bottlebrush squirreltail
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 7 inches—light gray and light brownish gray gravelly coarse sand
7 to 10 inches—light gray silt loam
10 to 26 inches—brown and pale brown clay and silty clay loam
26 to 60 inches—pale brown silty clay loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Moderately well drained
Ponding: 12 inches above the surface to a depth of 12 inches below the surface in March through May
Permeability: Very slow
Available water capacity: About 8 inches

Contrasting Inclusions

- Dester soils near terrace escarpments
- Ninemile soils on lava plains
- Choptie soils on knolls and hills
- Borobey soils in small basins and along drainageways

Major Use

Livestock grazing

Major Management Limitations

Wetness, climate, surface texture

General Management Considerations

- If seeding is needed, select plants that tolerate seasonal wetness.
- Grazing during wet periods can cause soil compaction and displacement and damage plants.
- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.

Range Site

Pumice Flat 9-11pz

148A—Swaler silt loam, 0 to 2 percent slopes

Composition

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

Setting

Landform: Lake terraces
Parent material: Lacustrine sediment
Elevation: 4,100 to 4,600 feet
Native plants: Mountain big sagebrush, Idaho fescue, Thurber needlegrass, Indian ricegrass, basin wildrye
Climatic factors:
Mean annual precipitation—10 to 12 inches

Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 10 inches—light gray and light brownish gray silt loam
10 to 26 inches—brown and pale brown clay and silty clay loam
26 to 60 inches—pale brown and brown silty clay loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Moderately well drained
Ponding: 12 inches above the surface to a depth of 12 inches below the surface in March through May
Permeability: Very slow
Available water capacity: About 8 inches

Contrasting Inclusions

- Reluctan and Ninemile soils on lava plains
- Borobey soils in small basins and along drainageways
- Swalesilver soils in closed basins

Major Use

Livestock grazing

Major Management Limitations

Wetness, climate

General Management Considerations

- If seeding is needed, select plants that tolerate seasonal wetness.
- Grazing during wet periods can cause soil compaction and displacement and damage plants.
- The cold climate and soil temperature delay the growth of forage and shorten the growing season.

Range Site

Dry Lakebed 10-12pz

149A—Swalesilver loam, 0 to 1 percent slopes

Composition

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

Setting

Landscape position: Closed basins
Landform: Lava plains
Parent material: Lacustrine sediment
Elevation: 4,300 to 4,600 feet
Native plants: Silver sagebrush, mat muhly, Nevada bluegrass, creeping wildrye
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 3 inches—light gray loam
3 to 5 inches—light gray silt loam
5 to 18 inches—light brownish gray clay
18 to 40 inches—grayish brown silty clay loam
40 to 50 inches—pale brown clay loam
50 to 60 inches—light olive brown loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Ponding: 12 inches above the surface to a depth of 12 inches below the surface in November through May
Permeability: Very slow
Available water capacity: About 11 inches

Contrasting Inclusions

- Reluctan soils on lava plains
- Swaler soils on drier edges of basins

Major Use

Livestock grazing

Major Management Limitations

Wetness, climate

General Management Considerations

- If seeding is needed, select plants that tolerate seasonal wetness.
- Grazing during wet periods can cause soil compaction and displacement and damage plants.
- The cold climate and soil temperature delay the growth of forage and shorten the growing season.

Range Site

Ponded Clay

150A—Tetherow sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over cinders
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 19 inches—brown sandy loam
19 to 24 inches—pale brown cobbly sandy loam
24 to 60 inches—dark reddish brown cinders

Soil Properties and Qualities

Depth: Cinders at a depth of 14 to 28 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that are deep to cinders

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the very rapid permeability of the substratum.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

150B—Tetherow sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Lava plains
Parent material: Ash over cinders
Elevation: 2,500 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 19 inches—brown sandy loam
19 to 24 inches—pale brown cobbly sandy loam
24 to 60 inches—dark reddish brown cinders

Soil Properties and Qualities

Depth: Cinders at a depth of 14 to 28 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 3 inches

Contrasting Inclusions

- Soils that are deep to cinders

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Surface texture, permeability, slope

General Management Considerations

Irrigated cropland

- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Applied fertilizers and chemicals may be leached and ground water may be contaminated because of the

very rapid permeability of the substratum.
• Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the risk of seepage.

Range Site

Pumice Flat 10-12pz

151D—Tetherow-Clovkamp complex, 8 to 50 percent slopes

Composition

Tetherow soil and similar inclusions—55 percent
Clovkamp soil and similar inclusions—30 percent
Contrasting inclusions—15 percent

Setting

Landform: Cinder cones
Slope range: Tetherow soil—8 to 50 percent; Clovkamp soil—8 to 25 percent
Parent material: Tetherow soil—ash over cinders (fig. 11); Clovkamp soil—ash

Figure 11.—Gravel pit used as a source of cinders in an area of Tetherow-Clovkamp complex, 8 to 50 percent slopes.

Elevation: 2,500 to 4,000 feet
Native plants: Tetherow soil—western juniper, Wyoming big sagebrush, bluebunch wheatgrass, Sandberg bluegrass; Clovkamp soil—western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile of the Tetherow Soil

0 to 7 inches—brown sandy loam
7 to 14 inches—brown sandy loam
14 to 60 inches—dark reddish brown cinders

Properties and Qualities of the Tetherow Soil

Depth: Cinders at a depth of 14 to 28 inches; bedrock at a depth of 60 inches or more
Drainage class: Excessively drained
Permeability: Moderately rapid over very rapid
Available water capacity: About 2 inches

Typical Profile of the Clovkamp Soil

0 to 12 inches—grayish brown and brown loamy sand
12 to 24 inches—brown loamy sand
24 to 40 inches—pale brown gravelly loamy fine sand
40 to 60 inches—pale brown extremely gravelly sand

Properties and Qualities of the Clovkamp Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Moderate
Available water capacity: About 5 inches

Contrasting Inclusions

• Soils that have a weakly cemented layer at a depth of 10 to 40 inches
• Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Surface texture, permeability, slope

General Management Considerations

• Care should be taken to protect these soils from wind erosion when applying range improvement practices.
• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the risk of seepage.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
• The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

Tetherow soil—Cindery Hills 10-12pz
Clovkamp soil—Pumice Flat 10-12pz

152A—Tumalo sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 18 inches—grayish brown sandy loam
18 to 32 inches—pale brown very gravelly sandy loam
32 to 44 inches—very pale brown indurated duripan
44 to 90 inches—black and very pale brown extremely gravelly sand

Soil Properties and Qualities

Depth: Duripan at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately rapid above the duripan and very rapid below the duripan
Available water capacity: About 4 inches

Contrasting Inclusions

• Soils that have a loamy sand or gravelly sandy loam surface layer
• Deschutes and Plainview soils in swales

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, permeability

General Management Considerations

Irrigated cropland

• Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
• Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.

Livestock grazing

• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth and risk of seepage.

Range Site

Pumice Flat 10-12pz

152B—Tumalo sandy loam, 3 to 8 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 3,000 to 4,000 feet
Native plants: Western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, needleandthread
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—70 to 100 days

Typical Profile

0 to 18 inches—grayish brown sandy loam
18 to 32 inches—pale brown very gravelly sandy loam
32 to 44 inches—very pale brown indurated duripan
44 to 90 inches—black and very pale brown extremely gravelly sand

Soil Properties and Qualities

Depth: Duripan at a depth of 20 to 40 inches; bedrock at a depth of more than 60 inches

Drainage class: Well drained
Permeability: Moderately rapid above the duripan and very rapid below the duripan
Available water capacity: About 4 inches

Contrasting Inclusions

- Soils that have a loamy sand or gravelly sandy loam surface layer
- Deschutes and Plainview soils in swales

Major Uses

Irrigated cropland, livestock grazing

Major Management Limitations

Soil depth, surface texture, slope, permeability

General Management Considerations

Irrigated cropland

- Well-managed irrigation systems are needed for deep-rooted crops such as alfalfa.
- Because the surface layer is sandy loam, this soil is subject to wind erosion if left unprotected.
- Because of the steepness of slope, sprinkler irrigation systems should be used to minimize runoff.

Livestock grazing

- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and risk of seepage.

Range Site

Pumice Flat 10-12pz

153A—Tutni loamy coarse sand, 0 to 3 percent slopes

Composition

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

Setting

Landform: Pumice-mantled stream terraces
Parent material: Ash and pumice over old alluvium and colluvium
Elevation: 4,100 to 4,400 feet
Native plants: Lodgepole pine, bearberry
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

1 inch to 0—organic mat
0 to 10 inches—pale brown loamy coarse sand
10 to 43 inches—light yellowish brown very gravelly coarse sand
43 to 60 inches—brown sandy loam

Soil Properties and Qualities

Depth: Old alluvium at a depth of 40 to 60 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: 18 to 48 inches below the surface in April through June
Permeability: Rapid over moderately rapid
Available water capacity: About 4.5 inches

Contrasting Inclusions

- Soils that are very poorly drained or moderately well drained
- Lapine soils in higher positions

Major Use

Woodland

Major Management Limitations

Frost potential, wetness, rooting depth, low fertility, susceptibility to compaction

General Management Considerations

- Seedlings have a moderate survival rate because of the frost potential.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because roots are restricted by the seasonal high water table and the coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
- The seasonal high water table restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

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154A—Vergas loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Lake terraces
Parent material: Old alluvium
Elevation: 4,200 to 4,600 feet
Native plants: Basin big sagebrush, basin wildrye, bluebunch wheatgrass, Idaho fescue
Climatic factors:
Mean annual precipitation—10 to 12 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Typical Profile

0 to 10 inches—light brownish gray and grayish brown loam
10 to 25 inches—pale brown clay loam
25 to 29 inches—pale brown gravelly loam
29 to 60 inches—pale brown, hard and brittle extremely gravelly loamy sand

Soil Properties and Qualities

Depth: Hard, brittle layer at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Slow
Available water capacity: About 6 inches

Contrasting Inclusions

- Reluctan soils on higher toe slopes
- Swaler and Swalesilver soils in depressions

Major Use

Livestock grazing

Major Management Limitations

Climate, permeability

General Management Considerations

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Pond development is limited by the risk of seepage.

Range Site

Swale 10-14pz

155C—Wanoga sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

1 inch to 0—organic mat
0 to 12 inches—brown sandy loam
12 to 24 inches—brown sandy loam
24 to 34 inches—weathered tuff
34 inches—unweathered tuff

Soil Properties and Qualities

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

Contrasting Inclusions

- Fremkle and Henkle soils on ridges
- Rock outcrop

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, surface texture, soil depth, permeability, low fertility, susceptibility to compaction

General Management Considerations

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, the

risk of seepage, and the steepness of slope in some areas.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Woodland

• Seedlings have a moderate survival rate because of the low precipitation.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Pine-Juniper-Bitterbrush-Fescue

155D—Wanoga sandy loam, 15 to 30 percent slopes

Composition

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

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

1 inch to 0—organic mat
0 to 12 inches—dark brown sandy loam
12 to 24 inches—brown sandy loam
24 to 34 inches—weathered tuff
34 inches—unweathered tuff

Soil Properties and Qualities

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

Contrasting Inclusions

• Fremkle and Henkle soils on ridges
• Rock outcrop

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, surface texture, soil depth, permeability, slope, low fertility, susceptibility to compaction

General Management Considerations

Livestock grazing

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Care should be taken to protect the soil from wind erosion when applying range improvement practices.
• Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
• The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Woodland

• Seedlings have a moderate survival rate because of the low precipitation.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Pine-Juniper-Bitterbrush-Fescue

155E—Wanoga sandy loam, 30 to 50 percent slopes

Composition

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

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

1 inch to 0—organic mat
0 to 12 inches—dark brown sandy loam
12 to 24 inches—brown sandy loam
24 to 34 inches—weathered tuff
34 inches—unweathered tuff

Soil Properties and Qualities

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

Contrasting Inclusions

- Fremkle and Henkle soils on ridges
- Rock outcrop

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, surface texture, soil depth, permeability, slope, low fertility, susceptibility to compaction

General Management Considerations

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
- The included areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.
- The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.

Woodland

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Using machinery only in areas covered with logging

slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Pine-Juniper-Bitterbrush-Fescue

156C—Wanoga-Fremkle-Henkle complex, 0 to 15 percent slopes

Composition

Wanoga soil and similar inclusions—35 percent
Fremkle soil and similar inclusions—30 percent
Henkle and similar inclusions—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Wanoga soil—ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge; Fremkle and Henkle soils—western juniper, ponderosa pine, mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Wanoga Soil

1 inch to 0—organic mat
0 to 12 inches—dark brown sandy loam
12 to 24 inches—brown sandy loam
24 to 34 inches—weathered tuff
34 inches—unweathered tuff

Properties and Qualities of the Wanoga Soil

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

Typical Profile of the Fremkle Soil

1 inch to 0—organic mat
0 to 14 inches—dark brown sandy loam
14 inches—tuff

Properties and Qualities of the Fremkle Soil

Depth: Bedrock at depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Henkle Soil

0.5 inch to 0—organic mat
0 to 17 inches—very dark brown and dark brown very cobbly sandy loam
17 inches—basalt

Properties and Qualities of the Henkle Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: About 1.5 inches

Contrasting Inclusions

• Laidlaw soils in swales
• Fryrear soils on side slopes and ridges

Major Uses

Livestock grazing, woodland

Major Management Limitations

Wanoga, Fremkle, and Henkle soils—climate, surface texture, permeability, soil depth, low fertility, susceptibility to compaction
Henkle soil—rock fragments in surface layer

General Management Considerations

Livestock grazing

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Care should be taken to protect the soils from wind erosion when applying range improvement practices.
• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth, the risk of seepage, and the steepness of slope in some areas.
• The restricted depth of the Fremkle and Henkle soils limits the choice of species for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is limited by the rock fragments on the surface of the Henkle soil.

Woodland

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because roots are restricted by the shallow depth of the Fremkle and Henkle soils, trees are subject to windthrow.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Wanoga soil—Pine-Juniper-Bitterbrush-Fescue
Fremkle and Henkle soils—Juniper-Pine-Fescue

156D—Wanoga-Fremkle-Henkle complex, 15 to 30 percent slopes

Composition

Wanoga soil and similar inclusions—35 percent
Fremkle soil and similar inclusions—30 percent
Henkle soil and similar inclusions—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Wanoga soil—ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge; Fremkle and Henkle soils—western juniper, ponderosa pine, mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Wanoga Soil

1 inch to 0—organic mat
0 to 12 inches—dark brown sandy loam
12 to 24 inches—brown sandy loam
24 to 34 inches—weathered tuff
34 inches—unweathered tuff

Properties and Qualities of the Wanoga Soil

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

Typical Profile of the Fremkle Soil

1 inch to 0—organic mat
0 to 14 inches—dark brown sandy loam
14 inches—tuff

Properties and Qualities of the Fremkle Soil

Depth: Bedrock at depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Typical Profile of the Henkle Soil

0.5 inch to 0—organic mat
0 to 17 inches—very dark brown and dark brown very cobbly sandy loam
17 inches—basalt

Properties and Qualities of the Henkle Soil

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: About 1.5 inches

Contrasting Inclusions

- Laidlaw soils in swales
- Fryrear soils on side slopes and ridges

Major Uses

Livestock grazing, woodland

Major Management Limitations

Wanoga, Fremkle, and Henkle soils—climate, surface texture, permeability, soil depth, slope, low fertility, susceptibility to compaction
Henkle soil—rock fragments in surface layer

General Management Considerations

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soils from wind erosion when applying range improvement practices.
- Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth, risk of seepage, and steepness of slope.

• The restricted depth of the Fremkle and Henkle soils limits the choice of species for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is limited by the rock fragments on the surface of the Henkle soil.

Woodland

• Seedlings have a moderate survival rate because of the low precipitation.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because roots are restricted by the shallow depth of the Fremkle and Henkle soils, trees are subject to windthrow.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Wanoga soil—Pine-Juniper-Bitterbrush-Fescue
Fremkle and Henkle soils—Juniper-Pine-Fescue

157C—Wanoga-Fremkle-Rock outcrop complex, 0 to 15 percent slopes

Composition

Wanoga soil and similar inclusions—35 percent
Fremkle soil and similar inclusions—30 percent
Rock outcrop—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Ash
Elevation: 2,800 to 4,000 feet
Native plants: Wanoga soil—ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge; Fremkle soil—western juniper, ponderosa pine, mountain big sagebrush, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Wanoga Soil

1 inch to 0—organic mat
0 to 12 inches—dark brown sandy loam
12 to 24 inches—brown sandy loam
24 to 34 inches—weathered tuff
34 inches—unweathered tuff

Properties and Qualities of the Wanoga Soil

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

Typical Profile of the Fremkle Soil

1 inch to 0—organic mat
0 to 14 inches—dark brown sandy loam
14 inches—tuff

Properties and Qualities of the Fremkle Soil

Depth: Bedrock at depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: About 2 inches

Contrasting Inclusions

• Henkle soils on ridges
• Laidlaw soils in swales
• Fryrear soils on side slopes and ridges

Major Uses

Livestock grazing, woodland

Major Management Limitations

Rock outcrop, climate, surface texture, permeability, soil depth, low fertility, susceptibility to compaction

General Management Considerations

Livestock grazing

• The cold climate and soil temperature delay the growth of forage and shorten the growing season.
• Care should be taken to protect the soils from wind erosion when applying range improvement practices.
• Because the soils are influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
• Pond development is limited by the soil depth, the risk of seepage, and the steepness of slope in some areas.
• The restricted depth of the Fremkle soil limits the

choice of species for range seeding to drought-tolerant varieties.
• The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Woodland

• Seedlings have a moderate survival rate because of the low precipitation.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because roots are restricted by the shallow depth of the Fremkle soil, trees are subject to windthrow.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• The areas of Rock outcrop force yarding and skidding paths to converge, which increases the risks of compaction and erosion throughout the unit.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Wanoga soil—Pine-Juniper-Bitterbrush-Fescue
Fremkle soil—Juniper-Pine-Fescue

158A—Wickiup loamy sand, 0 to 3 percent slopes

Composition

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

Setting

Landscape position: Swales and depressions
Landform: Stream terraces
Parent material: Volcanic ash and pumice
Elevation: 4,300 to 5,000 feet
Native plants: Lodgepole pine, sedges, and grasses
Climatic factors:
Mean annual precipitation—18 to 25 inches
Mean annual air temperature—40 to 44 degrees F
Frost-free period—10 to 50 days

Typical Profile

4 inches to 0—organic mat
0 to 4 inches—light brownish gray loamy sand
4 to 10 inches—very pale brown very gravelly coarse sand
10 to 60 inches—white extremely gravelly coarse sand

Soil Properties and Qualities

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Poorly drained
Depth to water table: At the surface to a depth of 30 inches below the surface from March through October
Permeability: Rapid
Available water capacity: About 3 inches

Contrasting Inclusions

• Soils that are moderately well drained or poorly drained
• Lapine soils in higher positions

Major Use

Woodland

Major Management Limitations

Wetness, frost potential, soil texture, low fertility, susceptibility to compaction

General Management Considerations

• Seedlings have a moderate survival rate because of the seasonal high water table and frost potential.
• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• Because roots are restricted by the seasonal high water table and the coarse-textured soil has insufficient anchoring capability, trees are subject to windthrow.
• The seasonal high water table restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
• Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
• Burning should be carefully planned to minimize detrimental impacts to the soil.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

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159C—Wilt sandy loam, 0 to 15 percent slopes

Composition

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

Setting

Landform: Hills
Parent material: Ash over residuum
Elevation: 2,800 to 4,000 feet
Native plants: Ponderosa pine, western juniper, mountain big sagebrush, antelope bitterbrush, Idaho fescue, Ross sedge
Climatic factors:
Mean annual precipitation—12 to 18 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile

0 to 13 inches—dark brown sandy loam
13 to 26 inches—dark brown cobbly loam
26 to 33 inches—dark brown very cobbly clay loam
33 inches—andesite

Soil Properties and Qualities

Depth: Residuum at a depth of 7 to 14 inches; bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 4.5 inches

Contrasting Inclusions

- Soils that have a very cobbly clay loam or clay subsoil
- Fryrear soils on side slopes

Major Uses

Livestock grazing, woodland

Major Management Limitations

Climate, surface texture, soil depth, low fertility, susceptibility to compaction

General Management Considerations

Livestock grazing

- The cold climate and soil temperature delay the growth of forage and shorten the growing season.
- Care should be taken to protect the soil from wind erosion when applying range improvement practices.
- Because the soil is influenced by pumice ash, reestablishment of the native vegetation is very slow if the vegetation is removed or deteriorated.
- Pond development is limited by the soil depth and by the steepness of slope in some areas.

Woodland

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Range Site

Pine-Juniper-Bitterbrush-Fescue

160C—Windego-Parrego complex, 0 to 15 percent slopes

Composition

Windego soil and similar inclusions—45 percent
Parrego soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses
Climatic factors:
Mean annual precipitation—15 to 25 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Typical Profile of the Parrego Soil

3 inches to 0—organic mat

0 to 5 inches—dark brown sandy loam
5 to 13 inches—brown loam
13 to 24 inches—brown clay loam
24 inches—weathered tuff

Properties and Qualities of the Parrego Soil

Depth: Colluvium at a depth of 4 to 7 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Contrasting Inclusions

- Smiling soils on side slopes

Major Use

Woodland

Major Management Limitations

Climate, low fertility, susceptibility to compaction

General Management Considerations

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-13

160D—Windego-Parrego complex, 15 to 30 percent slopes

Composition

Windego soil and similar inclusions—45 percent
Parrego soil and similar inclusions—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium and residuum
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses
Climatic factors:
Mean annual precipitation—15 to 25 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Typical Profile of the Parrego Soil

3 inches to 0—organic mat
0 to 5 inches—dark brown sandy loam
5 to 13 inches—brown loam
13 to 24 inches—brown clay loam
24 inches—weathered tuff

Properties and Qualities of the Parrego Soil

Depth: Colluvium at a depth of 4 to 7 inches; soft bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 4 inches

Contrasting Inclusions

- Smiling soils on side slopes

Major Use

Woodland

Major Management Limitations

Climate, slope, low fertility, susceptibility to compaction

General Management Considerations

- Seedlings have a moderate survival rate because of the low precipitation.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.

• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CP-S2-13

161E—Windego-Smiling complex, 30 to 50 percent slopes

Composition

Windego soil and similar inclusions—55 percent
Smiling soil and similar inclusions—30 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 2,500 to 3,500 feet
Native plants: Windego soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses; Smiling soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 40 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

• Soils that have bedrock at a depth of 20 to 40 inches
• Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

• Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
• Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
• High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
• Cuts and fills can be protected from erosion by seeding with grass and mulching.
• Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
• Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Windego soil—CP-S2-13
Smiling soil—CP-S2-17

162E—Windego-Smiling complex, cool, 30 to 50 percent slopes

Composition

Windego soil and similar inclusions—50 percent
Smiling soil and similar inclusions—35 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 3,500 to 4,000 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush, chinkapin, brackenfern
Climatic factors:
Mean annual precipitation—30 to 50 inches
Mean annual air temperature—40 to 45 degrees F
Frost-free period—50 to 70 days

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Rock outcrop on ridges

Major Use

Woodland

Major Management Limitations

Slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Using machinery only in areas covered with logging slash or brush reduces soil displacement.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CW-C2-11

163D—Windego-Smiling-Rock outcrop complex, 0 to 30 percent slopes

Composition

Windego soil and similar inclusions—50 percent
Smiling soil and similar inclusions—25 percent
Rock outcrop—20 percent
Contrasting inclusions—5 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 2,500 to 3,500 feet
Native plants: Windego soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses; Smiling soil—ponderosa pine,

antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 40 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam
30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Parrego soils on side slopes of Green Ridge

Major Use

Woodland

Major Management Limitations

Rock outcrop, slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Wheeled and tracked equipment can be used; however, cable yarding generally is safer and disturbs the soil less.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Windego soil—CP-S2-13
Smiling soil—CP-S2-17

163E—Windego-Smiling-Rock outcrop complex, 30 to 70 percent slopes

Composition

Windego soil and similar inclusions—50 percent
Smiling soil and similar inclusions—25 percent
Rock outcrop—20 percent
Contrasting inclusions—5 percent

Setting

Landform: Mountains
Parent material: Ash over colluvium
Elevation: 2,500 to 3,500 feet
Native plants: Windego soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, needlegrasses; Smiling soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 40 inches
Mean annual air temperature—42 to 47 degrees F
Frost-free period—60 to 90 days

Typical Profile of the Windego Soil

1 inch to 0—organic mat
0 to 19 inches—dark brown and brown sandy loam
19 to 30 inches—brown very cobbly loam

30 to 60 inches—dark brown and yellowish brown very cobbly clay loam

Properties and Qualities of the Windego Soil

Depth: Colluvium at a depth of 14 to 25 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 6 inches

Typical Profile of the Smiling Soil

1 inch to 0—organic mat
0 to 16 inches—very dark brown and dark brown sandy loam
16 to 39 inches—dark brown loam
39 to 63 inches—dark brown clay loam

Properties and Qualities of the Smiling Soil

Depth: Colluvium at a depth of 14 to 33 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: About 10 inches

Contrasting Inclusions

- Soils that have bedrock at a depth of 20 to 40 inches
- Parrego soils on side slopes of Green Ridge

Major Use

Woodland

Major Management Limitations

Rock outcrop, slope, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Using machinery only in areas covered with logging slash or brush reduces soil displacement.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Windego soil—CP-S2-13
Smiling soil—CP-S2-17

164A—Wizard sandy loam, 0 to 3 percent slopes

Composition

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

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, white fir, common snowberry, twinflower
Climatic factors:
Mean annual precipitation—20 to 35 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile

2 inches to 0—organic mat
0 to 23 inches—dark brown sandy loam
23 to 28 inches—dark yellowish brown cobbly sandy loam
28 to 65 inches—dark yellowish brown very cobbly sandy loam

Soil Properties and Qualities

Depth: Glacial outwash at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: At the surface to a depth of 24 inches below the surface in April through June
Permeability: Moderately rapid
Available water capacity: About 6 inches

Contrasting Inclusions

- Allingham and Circle soils in higher positions
- Flarm soils in swales

Major Use

Woodland

Major Management Limitations

Wetness, low fertility, susceptibility to compaction

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because roots are restricted by the seasonal high water table, trees are subject to windthrow.
- The seasonal high water table restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
- Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

CD-S6-12

165C—Wizard-Allingham complex, 0 to 15 percent slopes

Composition

Wizard soil and similar inclusions—45 percent
Allingham soil and similar inclusions—45 percent
Contrasting inclusions—10 percent

Setting

Landform: Outwash plains
Parent material: Ash over glacial outwash
Elevation: 2,500 to 3,500 feet
Native plants: Wizard soil—ponderosa pine, white fir, common snowberry, twinflower; Allingham soil—ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—20 to 35 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Wizard Soil

2 inches to 0—organic mat
0 to 23 inches—dark brown sandy loam
23 to 28 inches—dark yellowish brown cobbly sandy loam
28 to 65—dark yellowish brown very cobbly sandy loam

Properties and Qualities of the Wizard Soil

Depth: Glacial outwash at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Somewhat poorly drained
Depth to water table: At the surface to a depth of 24 inches below the surface in April through June
Permeability: Moderately rapid
Available water capacity: About 6 inches

Typical Profile of the Allingham Soil

1 inch to 0—organic mat
0 to 16 inches—very dark grayish brown and dark brown gravelly sandy loam
16 to 28 inches—dark brown loam
28 to 65 inches—dark yellowish brown very gravelly and very cobbly clay loam

Properties and Qualities of the Allingham Soil

Depth: Glacial outwash at a depth of 20 to 40 inches; bedrock at a depth of 60 inches or more
Drainage class: Well drained
Permeability: Moderate
Available water capacity: About 8 inches

Contrasting Inclusions

- Circle soils in higher positions
- Flarm soils in swales and channels

Major Use

Woodland

Major Management Limitations

Wizard and Allingham soils—low fertility, susceptibility to compaction
Wizard soil—wetness

General Management Considerations

- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Because roots are restricted by the seasonal high water table, trees on the Wizard soil are subject to windthrow.
- The seasonal high water table in the Wizard soil restricts the use of equipment to midsummer when the soil is dry or to midwinter when the soil is frozen.
- Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.

• Because of the moderate susceptibility to compaction, designated skid trails should be used.

Forest Service Plant Association

Wizard soil—CD-S6-12
Allingham soil—CP-S2-17

166D—Xerolls, 5 to 50 percent slopes

Composition

Xerolls and similar inclusions—95 percent
Contrasting inclusions—5 percent

Setting

Landform: Slumps and landslides
Parent material: Colluvium and ash
Elevation: 1,400 to 2,000 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—47 to 52 degrees F
Frost-free period—110 to 140 days

Representative Profile

0 to 6 inches—grayish brown loam
6 to 18 inches—grayish brown loam
18 to 60 inches—light brownish gray sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 60 inches or more
Drainage class: Moderately well drained to somewhat excessively drained
Permeability: Moderately rapid to slow
Available water capacity: 2 to 6 inches

Contrasting Inclusions

• Rock outcrop

Major Use

Livestock grazing

Major Management Limitations

Soil depth, permeability, climate, slope, aspect

General Management Considerations

• Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
• The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
• The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range site

Onsite investigation is needed to determine the range site.

167E—Xerolls-Rock outcrop complex, 30 to 65 percent north slopes

Composition

Xerolls and similar inclusions—60 percent
Rock outcrop—25 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Basalt, welded tuff, ash
Elevation: 4,000 to 5,500 feet
Native plants: Western juniper, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—43 to 45 degrees F
Frost-free period—50 to 90 days

Representative Profile of Xerolls

0 to 6 inches—grayish brown very stony loam
6 to 18 inches—grayish brown loam
18 to 60 inches—light brownish gray sandy loam

Properties and Qualities of Xerolls

Depth: Bedrock at a depth of 10 to 60 inches or more
Drainage class: Moderately well drained to somewhat excessively drained
Permeability: Moderately rapid to slow
Available water capacity: 2 to 6 inches

Contrasting Inclusions

• Reluctan and Ninemile soils on lava plains
• Swaler and Borobey soils on toe slopes
• Choptie soils in ravines and on escarpments

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, soil depth, permeability, climate, slope

General Management Considerations

• Pond development is limited by the soil depth and

risk of seepage.
• The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
• The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

Pumice North 9-12pz

168E—Xerolls-Rock outcrop complex, 30 to 65 percent south slopes

Composition

Xerolls and similar inclusions—45 percent
Rock outcrop—40 percent
Contrasting inclusions—15 percent

Setting

Landform: Hills
Parent material: Basalt, welded tuff, ash
Elevation: 3,000 to 5,500 feet
Native plants: Western juniper, Wyoming big sagebrush, antelope bitterbrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—46 to 48 degrees F
Frost-free period—50 to 90 days

Representative Profile of Xerolls

0 to 6 inches—grayish brown very stony loam
6 to 18 inches—grayish brown loam
18 to 60 inches—light brownish gray sandy loam

Properties and Qualities of Xerolls

Depth: Bedrock at a depth of 10 to 60 inches or more
Drainage class: Moderately well drained to somewhat excessively drained
Permeability: Moderately rapid to slow
Available water capacity: 2 to 6 inches

Contrasting Inclusions

• Reluctan and Ninemile soils on lava plains
• Swaler and Borobey soils on toe slopes
• Choptie soils in ravines and on escarpments

Major Use

Livestock grazing

Major Management Limitations

Rock outcrop, soil depth, permeability, climate, slope, aspect

General Management Considerations

• Pond development is limited by the soil depth, risk of seepage, and steepness of slope.
• The low annual precipitation and restricted soil depth limit productivity and limit the choice of species for range seeding to drought-tolerant varieties.
• The steepness of slope restricts livestock distribution and limits range seeding with ground equipment.
• The steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.
• The areas of Rock outcrop limit the areas suitable for grazing and restrict accessibility by livestock.

Range Site

South 9-12pz

169C—Yapoah-Rock outcrop complex, 0 to 15 percent slopes

Composition

Yapoah soil and similar inclusions—70 percent
Rock outcrop—20 percent
Contrasting inclusions—10 percent

Setting

Landform: Mountains
Parent material: Ash and colluvium
Elevation: 3,200 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Yapoah Soil

2 inches to 0—organic mat
0 to 12 inches—dark brown very cobbly loamy sand
12 to 60 inches—dark yellowish brown extremely flaggy loamy sand

Properties and Qualities of the Yapoah Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Sisters soils on side slopes
- Soils that have bedrock at a depth of 20 to 60 inches

Major Use

Woodland

Major Management Limitations

Rock outcrop, available water capacity, rock fragments

General Management Considerations

- Seedlings have a poor survival rate because of the low available water capacity.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Rock fragments in the soil restrict the planting of seedlings.

Forest Service Plant Association

CP-S2-17

169E—Yapoah-Rock outcrop complex, 15 to 75 percent slopes

Composition

Yapoah soil and similar inclusions—65 percent
Rock outcrop—20 percent
Contrasting inclusions—15 percent

Setting

Landform: Mountains
Parent material: Ash and colluvium
Elevation: 3,200 to 5,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue
Climatic factors:
Mean annual precipitation—18 to 30 inches
Mean annual air temperature—40 to 47 degrees F
Frost-free period—50 to 90 days

Typical Profile of the Yapoah Soil

2 inches to 0—organic mat
0 to 12 inches—dark brown very cobbly loamy sand
12 to 60 inches—dark yellowish brown extremely flaggy loamy sand

Properties and Qualities of the Yapoah Soil

Depth: Bedrock at a depth of 60 inches or more
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: About 2 inches

Contrasting Inclusions

- Sisters soils on side slopes
- Soils that have bedrock at a depth of 20 to 60 inches

Major Use

Woodland

Major Management Limitations

Rock outcrop, available water capacity, slope, rock fragments

General Management Considerations

- Seedlings have a poor survival rate because of the low available water capacity.
- Unless the site is properly prepared and maintained, undesirable plants may compete with reforestation.
- Competing vegetation can be reduced by mechanical treatment, chemical treatment, or livestock grazing.
- High-lead logging or other logging systems that fully or partially suspend logs generally are safer and less damaging to the soil surface.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity.
- Burning should be carefully planned to minimize detrimental impacts to the soil.
- Cuts and fills can be protected from erosion by seeding with grass and mulching.
- Reduce erosion and sedimentation by using water bars and relief culverts; insloping, outsloping, or crowning road surfaces; using sediment traps; and undulating road grades.
- Reduce the risk of erosion on tractor skid roads and

temporary roads by seeding, installing water bars, subsoiling, or accumulating slash on the surface.
• Because of the low fertility of the subsoil, displacement of the surface layer should be minimized.
• Using machinery only in areas covered with logging slash or brush reduces soil displacement.
• Rock fragments in the soil restrict the planting of seedlings.

Forest Service Plant Association

CP-S2-17

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 and woodland; 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

By Rich Edlund and Ray Wilson, district conservationists, Natural Resources Conservation Service.

Cropland comprises about 10 percent of the survey area. General management needed for crops and pasture is suggested in this section. The estimated yields of the important crops or hay and pasture plants are given, the system of land capability classification used by the Natural Resources Conservation Service is explained, and prime farmland is described.

This section provides information about the agricultural potential of the survey area and suggests the management needed to help maintain this potential. This information is useful to agricultural producers, equipment and fertilizer dealers, land use planners, contractors, and conservationists. Information about the management of each soil is given in the section “Detailed Soil Map Units.” This information is useful in planning management systems for individual farms and fields.

According to the 1987 Census of Agriculture, approximately 90,000 acres in Jefferson County was used as cropland. Of this, about 45,000 acres was used for irrigated crops. Most of the irrigated cropland is in the vicinity of Madras, Metolius, and Culver. In Deschutes County, there are about 60,000 acres of irrigated cropland, pastureland, and hayland. Most of this land is in the vicinity of Redmond, Bend, Alfalfa, and Terrebonne. In Klamath County, it is not economically feasible to grow crops because of the cool temperatures in summer and the short growing season.

Nonirrigated cropland is scattered throughout the survey area. A grain-fallow rotation system is used on most of this land. Alfalfa is incorporated into the rotation in some areas.

Soils have various properties that affect use and management. Susceptibility to erosion by water and wind is an important consideration. Erosion results in a loss of organic matter and a breakdown of soil structure, and it changes soil texture through a loss of sand, silt, and clay. Onsite effects of erosion include degradation of soil tilth and loss of productivity, and offsite effects include degradation of water and air quality. It takes many years to replace soil lost through erosion.

The survey area has a wide range of soils and climatic conditions that influence use and management for crops and pasture. The northern part of the survey area, in Jefferson County, has the most favorable conditions for crop production. Elevation is 2,300 to

2,600 feet. The frost-free period is about 100 days, and the annual rainfall is less than 12 inches. Crops grown under irrigation include wheat, barley, grass seed, mint, alfalfa hay, potatoes, and seed crops such as garlic, flowers, radishes, and carrots.

Soils of the Madras and Agency series make up the majority of the acreage under cultivation. These soils are moderately fine textured and are moderately deep to bedrock. They are limited by the permeability of the subsoil and the sandy loam texture of the surface layer. Irrigation water should be applied according to the infiltration rate and permeability of the soils. Overirrigating contributes to erosion and runoff. Soil particles transported by water carry nutrients and chemicals into waterways and reservoirs, reducing storage capacity and making costly cleanup operations necessary. The quality of the water is degraded, making it less suitable for irrigation, livestock, and domestic use. Wind erosion is a concern in the areas of Madras and Agency soils that have a sandy loam surface layer. In addition to the loss of productivity, wind erosion creates a safety hazard on highways and results in deposition of soil material in waterways and reservoirs.

The Calimus soils are similar to the Madras and Agency soils, but they are less than 20 inches deep to bedrock. The very low available water capacity and the slow permeability of the subsoil in the Calimus soils make careful scheduling of irrigation necessary to avoid overland flow and crop stress.

Soils of the Era series are very deep and moderately coarse textured, and they have few limitations for crop production. These soils are in areas of nearly level to rolling topography. Sprinkler irrigation systems should be used in areas that have slopes of more than 3 percent to minimize erosion. Use of minimum tillage, crop residue, and windbreaks is needed to reduce wind erosion.

In the southern part of Jefferson County and the western part of Deschutes County, the soils and climatic conditions change dramatically. Elevation is 3,000 feet at Redmond and 3,500 feet at Bend. The frost-free period is about 80 days, which limits the choice of crops. Agriculture consists mainly of irrigated pasture and hay and smaller acreages of potatoes for seed, mint for rootstock and oil, and spring grain. The soils include those of the Clovkamp, Deschutes, Houstake, Tumalo, and Deskamp series. These soils consist of sandy loam and loamy sand influenced by pumice ash deposited from Mt. Mazama. The texture affects the infiltration rate, permeability, and available water capacity. Because of the high infiltration rate and the moderately rapid or rapid permeability, applying irrigation water at a higher rate than is typical for the needs of the crop grown is common. Sprinkler irrigation is best suited because the rate and frequency of application can be regulated according to individual crop needs. The very low or low available water capacity, which is a result of the soil depth and texture, makes more frequent applications necessary.

The infiltration rate is determined by the texture, structure, and organic matter content of a soil. For example, sandy soils have a high infiltration rate but they have a low available water capacity. Conversely, clayey soils absorb water slowly but they have a relatively high available water capacity. Various crops require differing amounts of water for full production. Applying adequate water during critical growth stages helps to maintain high production and desirable crop quality.

Many structural, management, and vegetative practices are used to reduce or control erosion by wind and water. Soils that have a bare surface are highly susceptible to wind and water erosion. Plant cover reduces the impact of raindrops and decreases the erosive energy of wind. It also increases the rate of infiltration of water into the soil profile. Windbreaks reduce the velocity of the wind, thus reducing the risk of erosion. Maintaining crop residue on the soil surface reduces erosion, increases the infiltration rate, and incorporates organic matter into the soil, which increases the available water capacity and the content of nutrients.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit 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, barnyard manure, and green manure crops; 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.

Crops other than those shown in the table are grown in the survey area, but estimated yields are not listed because the acreage of such crops may be small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The 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 *(24)*, 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 in this survey area 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 8 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 168,000 acres, or about 10 percent of the survey area, 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 or potential prime farmland are listed in 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:

1A Agency sandy loam, 0 to 3 percent slopes
2A Agency loam, 0 to 3 percent slopes
2B Agency loam, 3 to 8 percent slopes
3B Agency-Madras complex, 0 to 8 percent slopes
23A Buckbert sandy loam, 0 to 3 percent slopes
26A Clinefalls sandy loam, 0 to 3 percent slopes
27A Clovkamp loamy sand, 0 to 3 percent slopes
28A Clovkamp loamy sand, bedrock substratum, 0 to 3 percent slopes
31A Deschutes sandy loam, 0 to 3 percent slopes
31B Deschutes sandy loam, 3 to 8 percent slopes
32A Deschutes sandy loam, dry, 0 to 3 percent slopes
33B Deschutes-Houstake complex, 0 to 8 percent slopes
36A Deskamp loamy sand, 0 to 3 percent slopes
36B Deskamp loamy sand, 3 to 8 percent slopes
37B Deskamp sandy loam, 3 to 8 percent slopes
44B Era sandy loam, 3 to 8 percent slopes
45A Era sandy loam, cobbly substratum, 0 to 3 percent slopes
65A Houstake sandy loam, 0 to 3 percent slopes
66A Houstake sandy loam, dry, 0 to 3 percent slopes
67A Houstake sandy loam, very gravelly substratum, 0 to 3 percent slopes
68A Iris silt loam, 0 to 1 percent slopes
71B Lafollette sandy loam, 3 to 8 percent slopes
86A Madras sandy loam, 0 to 3 percent slopes
86B Madras sandy loam, 3 to 8 percent slopes
87A Madras loam, 0 to 3 percent slopes
87B Madras loam, 3 to 8 percent slopes
98A Plainview sandy loam, 0 to 3 percent slopes
98B Plainview sandy loam, 3 to 8 percent slopes
104A Redmond sandy loam, 0 to 3 percent slopes
150A Tetherow sandy loam, 0 to 3 percent slopes
150B Tetherow sandy loam, 3 to 8 percent slopes
152A Tumalo sandy loam, 0 to 3 percent slopes
152B Tumalo sandy loam, 3 to 8 percent slopes

Rangeland

By Gene Hickman, range conservationist, Natural Resources Conservation Service.

Rangeland comprises about 60 percent of the survey area. It includes juniper savanna, shrub grassland, and meadows or riparian habitat. The rangeland is adjacent to the forest land along the foot slopes of the Cascade Mountains and extends eastward into central and eastern Oregon. The vegetation produced on rangeland helps to control erosion, conserve water, and maintain watersheds; provides habitat for wildlife; and offers scenic and recreational opportunities. Rangeland also provides important year-round forage for wildlife and livestock. For these reasons, it is important economically and environmentally.

Importance and Uses of Rangeland

Over the past century, livestock grazing has been one of the most significant uses of the rangeland. Although the number of livestock on the rangeland has declined in recent years, cattle grazing is still vital to

the local economy. Sheep ranchers once grazed large flocks in the survey area when moving to summer range in the Cascades. Most sheep operations have changed from large range flocks to smaller farm flocks. Horses and llamas have become a significant component of many livestock operations.

In addition to the historic and economic importance of the rangeland for livestock grazing, it is also important for many other uses. It helps to control flooding and prevent excessive soil erosion in watersheds and riparian areas. Rangeland watersheds capture, store, and release water for plant growth and for recharge of springs and streams.

Rangeland provides habitat for many game and nongame mammals and birds and for fish and other wildlife. Consequently, sport hunting and fishing are major industries in the survey area. Other recreation opportunities include wildlife viewing, photography, landscape painting, off-road vehicle use, and sightseeing.

Historically, local Native Americans obtained edible plants from the rangeland.

Broad Vegetative Zones

Livestock and wildlife in the survey area graze and browse in a wide variety of environments that support varied vegetative cover types. These broad zones, which are characterized by the dominant soils and potential native vegetation, are discussed in this section.

Natural vegetation in the survey area varies greatly because of the wide range in climate and the contrasting topographic features. In addition, an extensive mantle of ash and pumice covers much of the area. The soils have low inherent fertility, higher than expected available water capacity, and thermal properties that are less conducive to heat transfer.

From the high, moist, cold soils of the Cascade Mountains eastward to the dry, cool soils of the lava plains, known as the High Desert, climate is associated with the major differences in the types of vegetation over short distances. Precipitation decreases from 70 inches in the forests of the Cascade Mountains to about 8 inches in the Madras and Redmond areas. Soils that are influenced by ash and pumice extend nearly to the eastern boundary of the survey area.

From north to south in the survey area, there is a gradual decrease in temperature, increase in moisture, and increase in elevation. The warmer, lower elevations at the northern end of the area have the longest growing season. The soils have little ash and pumice influence except in some local deposits. The area south of Juniper Butte to Bend and west to Hampton has been influenced significantly by volcanic ash from Mt. Mazama. Soil temperatures in this zone become cooler as the content of ash and the elevation increase.

In the area south of Bend, the thickness of the ash and pumice mantle increases significantly. Temperatures are cold, and freezing temperatures may occur at any time during the year. The vegetation near Bend consists of ponderosa pine plant communities, and in the LaPine Basin it consists of lodgepole pine plant communities.

Mixed Conifer Zone. This zone is characterized by general soil map units 15 and 20. The forests commonly include various combinations of white fir, Douglas fir, ponderosa pine, incense cedar, and some lodgepole pine. The dense stands generally are not grazed by livestock unless the overstory canopy is opened by fire or logging. Forage is sparse in areas where there is an abundance of unpalatable evergreen shrubs such as chinkapin, snowbrush, manzanita, and Oregongrape. This zone traditionally has been used as summer range for both livestock and big game. It is characterized by cold temperatures in winter and cool temperatures in summer, and it receives the highest amount of precipitation of any part of the survey area. Deep snow commonly is on the ground throughout winter, and it remains until late in spring or early in summer. New plant growth occurs very late.

Ponderosa Pine Zone. This zone is characterized by general soil map units 14, 16, 18, and 19. Ponderosa pine forests are at the lower elevations and in areas that receive less precipitation than the adjacent mixed conifer zone. The ponderosa pine zone has two very distinct subdivisions based on understory vegetation. Manzanita and snowbrush are prominent in the understory of the cooler, more moist area adjacent to the mixed conifer zone. Antelope bitterbrush is dominant in the understory in the warmer, drier area adjacent to the sagebrush juniper zone. Forage is readily available throughout the ponderosa pine zone because of the abundance of palatable species such as Idaho fescue, bottlebrush squirreltail, needlegrass, Ross sedge, and antelope bitterbrush. This zone has a natural open overstory canopy, which allows light to reach the understory. As a result, palatable species are abundant and the zone is suited to grazing even with minimal forest management or harvesting.

Lodgepole Pine Zone. This zone is dominant in the LaPine Basin. It is characterized by general soil map units 2 and 3 and the associated meadows in general soil map unit 1. This very cold lava plain has very deep and deep deposits of pumice and ash and has interspersed buttes and low ridges. Lodgepole pine forests are dominant on the toe slopes and lower lying

flat areas that are affected by cold air drainage. Wet basins and poorly drained areas along the Upper Deschutes River system are associated with a variety of riparian communities. Higher lying areas on buttes and uplands support ponderosa pine forests and some mixed conifer forests.

Forage production is very high in the meadows in this zone. The pine forests, however, are less suited to grazing by livestock because of the scarcity of water and the very low production of herbaceous vegetation. These forests support a variety of understory shrubs, including dominantly antelope bitterbrush along with wax currant and in some places manzanita, bearberry, and squawcarpet. Herbaceous cover consists primarily of western needlegrass, bottlebrush squirreltail, Ross sedge, and Idaho fescue.

Sagebrush Juniper Zone. The sagebrush juniper zone is characterized by general soil map units 4, 5, 6, 7, 8, 9, 10, and 17. Western juniper is a key species in the management of rangeland and woodland. The amount and density of western juniper has increased over the last 150 to 300 years. This increase has been attributed to the control of fire and possibly other factors such as overgrazing and changes in climate *(21)*. Because range sites and associated plant species and composition are based on a climax plant community in which fire is considered to be a part of the ecosystem, western juniper is present on many soils in which it is not considered to be part of the historic climax plant community. Managers should compare the historic climax vegetative potential of a range or woodland site to the present-day vegetation. Suitable management alternatives depend on the objectives and goals of the land managers.

Within the sagebrush juniper zone, there are three important subdivisions based on soil properties. The southern part of the zone is strongly influenced by ash. It is characterized by general soil map units 5, 6, 8, and 17. The primary shrub species are mountain big sagebrush, rabbitbrush, desert gooseberry, and buckwheat. In areas that receive more than about 10 inches of precipitation, antelope bitterbrush commonly is the dominant shrub. The dominant grasses in the southern part include Idaho fescue, needleandthread, bottlebrush squirreltail, Indian ricegrass, Ross sedge, and bluebunch wheatgrass. Idaho fescue is less abundant and needleandthread is more abundant in the areas that receive less precipitation. Grazing is limited by the lack of natural surface water for livestock and by the extensive network of lava outcroppings. Reestablishment of western juniper is very slow after trees are removed by fire or mechanical means.

The northern part of the zone has minimal ash influence except for some local accumulation in the lower lying positions. This part is characterized by general soil map units 4, 7, and 9. The primary shrub species are basin big sagebrush, antelope bitterbrush, gray horsebrush, rabbitbrush, and buckwheat. The main grasses are bluebunch wheatgrass, Idaho fescue, Thurber needlegrass, Sandberg bluegrass, and bottlebrush squirreltail. Winters are mild in this part, and spring growth begins earlier because the growing season is longer.

A small area in this zone is represented by more clayey soils that are not influenced by ash. This area is characterized by general soil map unit 10. The primary shrubs and grasses are similar to those in the northern part of the this zone. Western juniper is more invasive on these soils, and it regenerates quickly after disturbance or if protected from fire. Because the soils are clayey and the topography is steep, the risk of water erosion is higher in this area than in other parts of the survey area.

Sagebrush Zone. This zone is in the eastern part of the survey area, extending eastward from the crest of Horse Ridge. It is characterized by general soil map units 11, 12, and 13. Temperatures are colder and the growing season is shorter than in the sagebrush juniper zone to the west. The sagebrush zone traditionally has been used for livestock grazing late in spring and in fall.

General soil map unit 11 is in a basin that is subject to cold air drainage. This unit does not support western juniper. The vegetation is dominantly mountain big sagebrush, Idaho fescue, and needlegrasses. In the southwestern part of the unit, near Pine Mountain, antelope bitterbrush is also a major species. This unit receives only about 10 to 12 inches of precipitation, which typically is considered inadequate for Idaho fescue. However, the coarse-textured soils are high in content of ash and have a higher than expected available water capacity, which compensates for the lower precipitation and allows Idaho fescue to become dominant. Areas of this unit are interspersed with numerous small, clayey basins that are ponded during spring runoff and support silver sagebrush and with dry drainageways that support basin wildrye and basin big sagebrush.

General soil map unit 12 is on a lava plain. The soils are shallow and have a thin mantle of ash. Western juniper is dominant in the plant community. Low sagebrush and mountain big sagebrush are the dominant shrubs, and Idaho fescue is the dominant grass. Areas of this unit are interspersed with seasonally ponded, clayey basins that support silver sagebrush and sparse herbaceous cover. The extreme eastern part of unit 12, near Hampton, has very little ash influence and is subject to less cold air drainage

than is unit 11. Because of the lower available water capacity and the slightly warmer temperatures, Wyoming big sagebrush and bluebunch wheatgrass are dominant in this part of the unit.

General soil map unit 13 is on hills. Western juniper is throughout much of this unit. Mountain big sagebrush is the dominant shrub, and Idaho fescue and needlegrasses are the dominant grasses.

Grazing Management

Livestock management includes many practices. The key to proper management is use of a grazing system designed with consideration of plant and animal requirements, topography, and management objectives. A grazing system includes pasture rotation, proper use of forage, proper timing and length of the grazing period, and rest or deferred grazing until after critical periods of plant growth. Other practices, such as fencing, salting, using water developments, controlling weeds and brush, thinning, and seeding, are used to facilitate the grazing system and to improve livestock distribution or to increase production.

An important objective of grazing management should be maintenance or improvement of the soil, water, and plant resources. Because of the economic impact and other considerations, the objective of management may not be to improve the range condition or site potential. However, proper management is needed to achieve an acceptable level of cover and production consistent with the limitations of the vegetative site. This level should conserve water, maintain water quality, and minimize erosion.

Limitations for Use

Soil characteristics can make an area unsuitable or less suitable for particular grazing practices. Important limitations are given in the section “Detailed Soil Map Units.” Some soil characteristics that could affect grazing management are described in this section.

Aspect is the direction in which a slope faces. North-facing slopes are cooler and more productive, but development of new growth occurs later in the year on these slopes. North-facing slopes are preferred by livestock and wildlife in summer. South-facing slopes generally have the opposite characteristics of north-facing slopes. Because south-facing slopes are warmer and drier, they are poorly suited to livestock grazing in summer. They are very important to wildlife in winter, however, because less snow accumulates on these slopes and they are the first to green up in spring. Southeast- and west-facing slopes have characteristics similar to those of south-facing slopes.

Droughtiness limits the production of forage and the choice of species suitable for seeding. Soils are droughty as a result of low annual precipitation or low available water capacity. Soil characteristics such as coarse texture, shallow depth, or a high content of rock fragments limit the available water capacity.

Cold temperatures restrict the length of the growing season. Below-normal daily temperatures during the growing season also suppress plant growth and delay plant development.

A *high water table* occurs seasonally in some soils and year-round in others. Wetness, even if the root zone is saturated only briefly, has a major effect on the composition and production of the plant community. This is particularly true if a soil is ponded or has a water table at or near the surface. Soils that have a water table near the surface are subject to compaction and displacement and the plants are subject to crown damage if grazing is allowed during wet periods. If these soils are seeded, mechanical site preparation is difficult because of the abundant vegetation and the limited period when equipment can be used. The species selected for seeding should be tolerant of seasonal wetness.

Rock outcrop and escarpments support little, if any, vegetation. In areas where they make up a significant portion of the map unit, the capacity of the unit for grazing is reduced proportionally. Outcroppings and escarpments act as physical barriers to all domestic livestock and to some wildlife, preventing or restricting movement.

Livestock water developments are needed in most of the grazeable areas in the survey area. Development of stock ponds is limited in many areas because of the lack of water sources, such as springs or runoff; insufficient soil depth; and a shortage of proper construction material. Unless material for sealing the ponds is brought in from outside the area, ponds can be constructed only in areas where the soil material naturally has slow permeability and can be compacted and sealed properly. Soils that are coarse textured, are high in content of rock fragments, or are shallow or moderately deep to bedrock are subject to excessive seepage and are poorly suited to pond construction. The high infiltration rate and rapid permeability of most of the soils in the area limit runoff. Water for ponds may need to be transported to an area or pumped from wells.

Steepness of slope affects livestock use and the feasibility of applying management practices. Areas that have slopes of 30 percent or less are preferred by livestock. Areas that have slopes of more than 50 percent receive very little use even if the forage is abundant. Limited use of the steeper slopes should be anticipated, and the stocking rates should be adjusted accordingly. Areas that have slopes of more than about

35 percent generally are not suited to mechanical seedbed preparation or to seeding with ground equipment.

Stones and cobbles on the surface can influence grazing management and the potential for revegetation. Some soils have so many stones and cobbles on the surface that livestock avoid the soils whenever possible. Stones can limit the feasibility of mechanical seedbed preparation and seeding.

Surface texture can affect the suitability for livestock grazing and for applying management practices. Some soils that have a silty surface layer are subject to crusting and are sticky when wet. The crusting of the surface reduces infiltration and restricts seedling emergence. Soils that have a clayey surface layer have a slow or very slow infiltration rate and are very sticky and very plastic when wet. The surface becomes rutted and compacted if the soil is grazed or traversed by equipment when wet. Most of the soils in the survey area have a coarse-textured, or sandy, surface layer. These soils are susceptible to wind erosion if the vegetation is removed or is sparse. Management of these soils should include maintaining adequate litter and plant cover. The coarse-textured soils that receive less than about 12 inches of precipitation are very susceptible to deterioration of the vegetative site. Loss of native perennial cover through fire, mechanical treatment, or overgrazing can result in a rapid conversion of a potential native plant community to invasive weedy brush and annual vegetation. Reestablishment of native bunchgrass plant communities is very slow.

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.

Woodland Management and Productivity

By Craig M. Ziegler and Russ Hatz, foresters, Natural Resources Conservation Service.

Forest land comprises about 30 percent of the survey area. It is concentrated in the southern and western parts of the area. A majority of the forest land is public land that is administered by the Forest Service. The remainder is owned by commercial timber companies and private landowners. Precipitation ranges from about 15 to 70 inches.

The forests in the southern part of the survey area are mainly in the LaPine Basin. Elevation in the basin ranges from about 4,000 to 5,000 feet or more. The soils are influenced by volcanic ash and pumice. At the southern end of the basin the deposits of volcanic ash and pumice are as much as 60 inches thick or more, and at the northern end they are about 24 inches thick. The soils are cold and are low in fertility. They have a high available water capacity, but they dry out very quickly early in the growing season. There are two main forest cover types in this part of the survey area—interior ponderosa pine and lodgepole pine *(19)*. The interior ponderosa pine type is on lava plains and hills. Many years of fire control have allowed lodgepole pine to become established in the understory. Areas of Lapine, Shanahan, and Steiger soils support this forest cover type. The lodgepole pine type is in low-lying or depressional areas on pumice-mantled lava plains. Cold air drainage is trapped in these areas, and the resulting frost is detrimental to ponderosa pine. Areas of Lapine, Shanahan, Steiger, Sunriver, Tutni, and Wickiup soils support this forest cover type.

The forests in the western part of the survey area are more diverse. The dominant forest cover type is interior ponderosa pine. It is at the lower elevations and in drier areas. Ponderosa pine is the dominant tree species, but Douglas fir, western larch, white fir, and western juniper occur in lesser amounts. The interior Douglas fir and white fir cover types generally are at the middle elevations, and the lodgepole pine cover type is at the higher elevations. The soils in the western part also have been influenced by volcanic activity. The layers of pumice and ash are a few inches thick to more than 60 inches thick. The farther away the soils are from the Cascade Range, the thinner the layers of pumice and ash. The proximity of the soils to various volcanic events and the direction and velocity of the wind also influence the thickness of the pumice and ash. The soils in this part have moderate fertility and high available water capacity.

Several large wood products manufacturers are in or near the survey area. Ponderosa pine, the most prevalent tree species, and Douglas fir and white fir are used for lumber, plywood, and wood chips. Lodgepole pine is used for wood chips, plywood, and fence posts. Dead lodgepole pine is used extensively for firewood.

Many diseases and insects affect the forests and can be a problem in individual stands of trees. Damage varies from year to year. The mountain pine beetle *(Dendroctonus ponderosae)* is very destructive to forests. Large numbers of lodgepole pine, the principal host, periodically are killed, and individual trees are killed annually. The pine engraver beetle also attacks pine species. The western spruce budworm *(Choristoneura occidentalis)* defoliates Douglas fir and white fir, dramatically reducing growth. The western pine beetle *(Dendroctonus brevicomis)* attacks larger pine trees, and the western pine shoot borer *(Eucosma sonomia)* attacks younger pine trees.

Dwarf mistletoe *(Arceuthobium spp.)* is one of the most destructive parasites that attacks ponderosa pine, Douglas fir, and western larch. Red ring rot *(Fomes pini)* is a disease that kills western larch and lodgepole pine. Shoestring root rot *(Armillaria mellea)* is a problem for pines under stress and for Douglas fir and true firs. Brown stringy rot *(Echinodontium tinctorium)* is a serious disease of Douglas fir and true firs.

Soil surveys are important to land managers as they seek ways to maximize the use of forest land. This survey provides to managers information that can be used to make sound management decisions. Table 7 can be used by woodland owners and forest managers in planning the use of the soils for wood crops. Only the soils suitable for wood crops are listed. *Slight*, *moderate*, and *severe* indicate the degree of the major soil limitations to be considered in management.

Sheet and rill erosion ratings refer to the probability of excessive erosion occurring as a result of operations that expose the soil. Forests that are burned or overgrazed are also subject to sheet and rill erosion. A *slight* rating indicates that no particular erosion-control measures are needed under ordinary conditions; *moderate* indicates that some erosion-control measures are needed; and *severe* indicates that extra precautions are needed to control erosion during most silvicultural activities.

Erosion hazard ratings are determined by considering the topography, the erodibility of a soil, and the local climate. Moderate and severe ratings may indicate the need to modify road construction, use special harvesting systems, and use alternative site preparation techniques.

Cut and fill erosion ratings refer to the probability that damage will occur as a result of erosion from road cuts and fills. All cuts and fills should be seeded. A

slight rating indicates that no other preventative measures are needed under ordinary conditions; *moderate* indicates that additional erosion-control measures, such as use of mulch and sediment traps, are needed under certain conditions; and *severe* indicates that additional erosion-control measures are needed under most conditions.

The texture of the surface layer and subsoil and the length and angle of the slope contribute to the extent of the cut and fill erosion. The risk of erosion is greater in areas where the cuts and fills are longer and the erodibility of the soil is higher.

Equipment limitation ratings refer to the limits on the use of equipment as a result of soil characteristics. A rating of *slight* indicates that equipment use normally is not restricted because of soil factors; *moderate* indicates a short seasonal limitation because of soil wetness, a fluctuating water table, or some other factor; and *severe* indicates a seasonal limitation, a need for special equipment, or a hazard in the use of equipment.

Steepness of slope, soil wetness, and the susceptibility of the soil to compaction are the main limitations for equipment use. As the gradient and length of the slope increase, use of wheeled equipment becomes more difficult. Tracked equipment can be used in some of the steeper areas, but cable yarding systems should be used in the steepest areas. Soil wetness, especially in areas of fine-textured material, can severely limit the use of equipment and make harvesting practical only during the dry period in summer.

Soil compaction ratings refer to the probability that damage will occur to the soil structure as a result of repeated use of equipment when the soil is wet or moist. Compaction should always be considered during silvicultural activities. A rating of *slight* indicates that the only special practices needed are use of designated skid trails and protection of the layer of duff; *moderate* indicates the potential need for extra precautions, such as use of cable yarding instead of ground skidding and seasonal restrictions on equipment use; and *severe* indicates the need for extreme caution and possibly some restorative activities, such as ripping or discing, following harvesting.

Thickness of the layer of duff, content of coarse fragments, texture, and plasticity are characteristics of the soil that are considered in the compaction ratings. Compaction decreases air spaces in the soil; thus, air and water movement are reduced, which restricts root growth and increases the risk of surface erosion.

Soil displacement ratings refer to the soil being gouged, scraped, or pushed from its natural position by mechanical means. Soil displacement is most often associated with mechanical slash disposal and site preparation. A *slight* rating indicates that equipment use is not restricted and that special precautions generally are not needed; *moderate* indicates that specialized equipment, such as a brush rake, should be used; and *severe* indicates that extreme caution is needed if mechanical slash disposal and site preparation are used.

Soil characteristics considered in the soil displacement ratings are thickness of the layer of duff, thickness of the surface layer, content of coarse fragments, and texture. Removing or mixing the layer of duff and exposing the mineral soil are necessary for natural regeneration of many species. If excessive soil displacement has occurred, however, plant recovery rates may be impaired. Because of the inherent low fertility of material influenced by pumice and ash, most of the nutrients and organic matter are in the upper few inches of the mineral soil. Prolonged exposure may increase the risk of erosion and further deteriorate the site.

Seedling mortality ratings refer to the probability of death of tree seedlings because of soil characteristics or topographic conditions. Plant competition is not considered in this rating. The ratings apply to healthy, dormant seedlings from good stock that are properly planted during a period of sufficient moisture. A rating of *slight* indicates that no problem is expected under normal conditions; *moderate* indicates that some problems can be expected and extra precautions are needed; and *severe* indicates that mortality will be high and extra precautions are needed for successful reforestation.

Soil wetness, droughtiness, and topographic conditions contribute to seedling mortality. To overcome these limitations, larger than normal planting stock, special site preparation, surface drainage, or reinforcement plantings may be needed.

Windthrow ratings refer to the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees normally are not blown down by the wind; *moderate* indicates that an occasional tree may be blown down during periods when the soil is wet and winds are moderate or strong; and *severe* indicates that many trees may be blown down during periods when the soil is wet and the winds are moderate or strong.

Restricted rooting depth because of a high water table, underlying bedrock, or an impervious layer and poor anchoring of roots because of loose soil material are the main factors contributing to the windthrow hazard. Moderate and severe ratings indicate the need

for care in thinning forest stands, periodic salvage of windblown trees, and adequate roads and trails to allow for salvage operations.

Plant competition ratings refer to the likelihood of the invasion of undesirable plants when openings are made in the tree canopy. A *slight* rating indicates that unwanted plants are not likely to retard the development of natural or planted seedlings; *moderate* indicates that competition will retard the development of natural or planted seedlings; and *severe* indicates that competition can be expected to prevent the development of natural or planted seedlings.

Favorable climate and soil characteristics result in plant competition problems. In many cases, the key to predicting plant competition is the quantity and proximity of seed sources of undesirable plants or the quantity of unwanted brush rootstock that will resprout after harvesting. Moderate and severe ratings indicate the need for careful and thorough site preparation and the potential need for mechanical or chemical treatment to retard the growth of competing vegetation.

Fire damage ratings refer to the probability that a fire of moderate fireline intensity (116 to 520 Btu's/sec/ft) will have a negative impact on the characteristics of the soil. A rating of *slight* indicates that negative impacts are not expected; *moderate* indicates that negative impacts, such as nonwettability and excessive erosion, may occur and extra caution is needed in planning prescribed fires; and *severe* indicates that negative impacts are likely to occur and extreme caution is needed in planning prescribed fires.

Thickness of the layer of duff, content of organic matter, and texture are soil characteristics considered in determining the ability of soil to resist fire damage. It may be necessary to burn in winter, use alternative lighting techniques, monitor the moisture content of the fuel, yard unmerchantable material, eliminate prescribed fires, or use erosion-control measures following burning.

In table 8, the potential productivity of forested soils is expressed as *site index*. The site index is the average height dominant and codominant trees will attain at a base age. For example, a site index of 70 (50-year base age) means that the dominant and codominant trees will reach an average height of 70 feet in 50 years and a site index of 120 (100-year base age) means that the dominant and codominant trees will reach an average height of 120 feet in 100 years.

While it seems logical that a soil with a site index of 90 is more productive than a soil with a site index of 70, such a conclusion can be made only if the same tree species are compared and if the site indexes were derived from the same equations or tables. The tables used to compute site index vary according to species, and more than one site index table can be used for an individual species. Any given soil may have more than one site index, depending on the number of species the soil supports. Several publications were used to determine site index for this survey area *(1, 2, 9, 10, 12, 14, 17)*.

To facilitate comparing the potential productivity of different soils, the table includes values for potential wood production expressed as *total yield (board feet per acre)* and *annual growth (cubic feet per acre)*. Estimates of volume are calculated at the culmination of the mean annual increment (CMAI). The annual amount of wood fiber produced by a stand of trees changes as the stand matures. Very little wood fiber is produced when the trees are small, but the amount increases rapidly as the trees approach physiological maturity. Once trees reach maturity, the annual growth rate begins to slow. CMAI is the estimated age at which a fully stocked stand achieves its highest average annual growth rate. It is the most efficient time to harvest as far as tree growth is concerned. Other factors, such as stumpage values, cost effectiveness, and management objectives, also should be considered in determining the best time to harvest.

As an example of how the table can be used, consider the Allingham soil in detailed soil map unit 4C. A fully stocked stand of ponderosa pine on this soil has a site index of 77; that is, the average height of the dominant and codominant trees at age 100 is 77 feet. If the stand is allowed to grow for 160 years, the predicted yield will be 33,400 board feet per acre. However, the stand will attain its maximum annual production of wood fiber (64 cubic feet per acre per year) at age 50.

The species under *common trees* that are indicated by a footnote notation are ones that are recommended for planting and are most suitable for commercial wood production.

Woodland Understory Vegetation

The detailed soil map units in this survey area have been correlated to a range site or plant association. The site or association, such as South 9-12pz or CD-S6-13, respectively, is given at the end of each map unit description. For those map units or components assigned to a range site, the vegetative information on production, characteristic vegetation, and composition is given in table 6. For those map units or components assigned to a plant association, the vegetative information on characteristic vegetation and composition is provided in the publication "Plant Associations of the Central Oregon Pumice Zone" *(20)*.

Windbreaks and Environmental Plantings

By Craig Ziegler, forester, Natural Resources Conservation Service.

Wind erosion can be a serious environmental and economic problem. It can reduce the productivity of a soil through the loss of topsoil. Properly designed windbreaks can increase crop yields. Many environmental changes occur on the leeward side of windbreaks, including reduced windspeed, decreased transpiration by plants, increased humidity, reduced evaporation, and increased soil moisture content.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals. The proper interval depends on the erodibility of the soil. Research has shown that field windbreaks can significantly increase crop yields. Cropland damage by wind erosion was at an all-time high during the latter half of the 1980's as a result of removal or deterioration of older, existing windbreaks. Field windbreaks offer farmers an effective conservation practice to reduce wind erosion.

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 of the soil affect the growth of trees and shrubs.

Droughtiness in summer and cold temperatures in winter can lower the survival rate of trees and shrubs in the survey area. Properly preparing the site before planting and controlling competing vegetation after planting are essential for establishing new windbreaks. Replanting during the first 3 to 5 years may be needed for fully stocked, effective windbreaks. Permanent irrigation with a drip system or other irrigation methods can be used to overcome droughtiness. Irrigation allows for healthier, denser, and faster growing windbreaks. Black polypropylene woven fabric can be used to control weeds and conserve moisture after the seedlings are planted. This fabric provides effective weed control within the rows for at least 5 years. It also provides good mulch, which aids in conserving moisture and minimizing extremes in soil temperature.

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

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils used as cropland. 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. Absence of an entry indicates that the soil is either unsuited to growing trees or the trees will not reach the given height unless irrigated. 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.

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

The soils typically used for irrigated crops have been placed into windbreak suitability groups based on soil properties that effect plant growth. A description of each group and the associated soils are given in the following paragraphs.

Soil Group 3—Loamy

The soils in this group are deep or very deep, loamy, and moderately well drained or well drained. These soils do not have a seasonal high water table within a depth of 36 inches of the surface, and they are not subject to flooding. The available water capacity is 7.0 inches or more. The upper 12 inches does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Buckbert, Houstake, and Iris soils are in this group.

Soil Group 5—Droughty

The soils in this group are deep or very deep and are loamy or loamy-skeletal. 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 4 to 7 inches. The upper 12 inches does not have free

carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Lafollette and Plainview soils are in this group.

Soil Group 6—Very Droughty

The soils in this group are moderately deep to very deep; are loamy, loamy-skeletal, sandy, or sandy-skeletal; and 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 to 4 inches. The upper 12 inches does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Caphealy and Deskamp soils are in this group.

Soil Group 6R—Moderately Deep, Favorable

The soils in this group are moderately deep; are loamy, clayey-skeletal, or loamy-skeletal; and are 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 4 inches or more. The upper 12 inches does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Agency, Deschutes, Madras, Redmond, and Tumalo soils are in this group.

Soil Group 7—Sandy

The soils in this group are deep or very deep, are sandy throughout, and are moderately well drained, 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 does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Clinefalls, Clovkamp, and Tetherow soils are in this group.

Soil Group 8—Loamy, Carbonates

The soils in this group are deep or very deep, loamy, and moderately well drained or well drained. They have a seasonal high water table at a depth of 36 inches or more. The available water capacity is 7 inches or more. The upper 12 inches has reaction (pH) of 7.9 or higher or has electrical conductivity (EC) of as high as 4 millimhos per centimeter. Era soils are in this group.

Soil Group 10—Unsuited

The soils in this group have one or more characteristics, such as depth, texture, drainage, available water capacity, or salts, that severely limit planting, survival, and growth of trees and shrubs. Examples include soils that are very shallow or shallow, soils that have very low available water capacity (less than 2 inches), soils that are very poorly drained or poorly drained and are saturated or ponded throughout the growing season, and soils that have toxic salts. The soils in this group generally are not suited to farmstead, feedlot, or field windbreaks; however, onsite investigation may determine that trees and shrubs can be planted if special treatment, such as irrigation or leaching of salts, is used. The selection of species should be tailored to the conditions of the altered site. Cullius, Gosney, Reuter, Statz, and Stukel soils are in this group.

Recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In the table, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or a combination of these measures.

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

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of

use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

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

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

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

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

By Ted Wise, wildlife ecologist, Oregon Department of Fish and Wildlife.

Wildlife habitat is the relationship of animals to plant communities. Animals use the successional stages of plant communities for food, breeding, and cover, including thermal and security cover. Many environmental factors, including soil type, moisture regime, microclimate, slope, elevation, and temperature, affect the animal and plant communities.

Habitat Types

The survey area supports many different habitat types. From west to east, the vegetation includes middle elevation East Cascade Range mixed conifer forests, ponderosa pine and lodgepole pine forests, juniper woodland, and arid areas of grassland sagebrush steppe. The elements of these habitat types and opportunities for enhancement are described briefly in this section.

Forested habitat is comprised of mixed conifers, including Douglas fir, white fir, ponderosa pine, and ponderosa pine-lodgepole pine associations, in varying proportions. Understory plants include snowbrush, manzanita, antelope bitterbrush, squaw currant, squawcarpet, brackenfern, longstolon sedge, Ross sedge, and various grasses and forbs.

Coniferous forest habitat provides thermal and security cover, forage substrate, and seeds. The standing conifer snags (dead trees) provide nesting and roosting habitat for primary excavators (woodpeckers), secondary cavity-nesting birds, and several species of owls that nest in large-diameter bowls in areas where the tops of trees have broken off. Bats also use standing dead trees as roosting sites. Fallen trees in various stages of decay provide necessary habitat for countless invertebrates, small rodents, reptiles, and amphibians. Fire has been a major component in the development of the East Cascade Range forest communities.

Wildlife enhancement practices suited to areas of forest habitat include the creation of forage areas through carefully planned thinnings. Thinning can be done either by mechanical means or by prescribed burning. Thermal and security cover can be improved by planting trees; however, 10 years or more is needed for an area to be partially filled. Trees that are adapted to the particular site characteristics should be planted. Other enhancement practices include maintaining more standing dead trees and large downed trees for use by cavity nesters and small mammals, creating brush piles, and supplementing shrubs with native plantings. Practices used should be carefully planned with clear objectives, and the negative and positive impacts to the wildlife in the area should be considered.

Nonforested rangeland habitat consists of shrubs, grasses, and associated forbs. Antelope bitterbrush, big sagebrush, rabbitbrush, gray horsebrush, bluebunch wheatgrass, western needlegrass, Thurber needlegrass, Idaho fescue, and Sandberg bluegrass are some of the plants associated with this habitat.

Elements of wildlife habitat on sagebrush-shrub rangeland include the shrubs that provide food, nesting areas, and thermal and security cover for animals. Shrubs are important for food in winter because snow may cover lower lying plants. Shrubs also act as shields from chilling winter winds. Wildlife need both forage and cover in close proximity in winter. The native bunchgrasses provide essential cover for newborn birds and the young of larger animals. The

grasses and various forbs provide forage in fall, spring, and summer.

Wildlife habitat enhancement practices suited to areas of nonforested rangeland include use of water developments, sound grazing strategies, prescribed burning to achieve a plant community that is a mosaic of plants in seral stages, and seedings and plantings to restore native plant communities. Protection of the soils in these areas should be a top priority. Maintaining the soil base ensures a medium for the growth of plants that are the essence of wildlife habitat.

Riparian habitat consists of vegetation that is dependent on rivers, streams, and springs. More species of wildlife use these areas than any other habitat type. Willows, alders, redosier dogwood, cattails, sedges, and rushes are a few of the riparian-associated plant species.

The elements of riparian habitat vary depending on the soils, topography, and water. Coniferous and deciduous trees are important as thermal, birthing, and loafing cover for animals that are confined to the ground. The trees provide forage for many birds and small animals. Standing dead trees and dead parts of trees provide habitat for primary excavators and secondary cavity-nesting birds. Shrubs and herbaceous plants provide opportunities for nesting and feeding. The grasses in these areas tend to stay greener longer and thus are more palatable during the dry months of the year. The rivers, streams, and springs in these areas provide drinking water for wildlife. Riparian areas serve as important travel corridors and stopover points for many wildlife species during daily and seasonal activities and migrations.

The best way to protect and enhance riparian habitat is to ensure that the resident vegetation is allowed to flourish. Grazing and farming practices should be designed to optimize the existing and potential riparian vegetation. Only in extreme cases is streambank stabilization needed to establish vegetation. Trees such as western juniper and brush can be used to stabilize streambanks. Cuttings and rootstock of resident species from nearby areas can be planted to help restore degraded sites.

Wetland habitat consists of open, marshy or swampy shallow water areas. Riparian communities, which are described in the preceding paragraphs, are one type of wetland habitat. Natural wetland sites are extremely important because artificial developments do not adequately mitigate for natural wetland systems. Pond developments provide habitat for some wetland species if the associated vegetation and varied slopes are maintained and protected. Cattails, sedges, rushes, pondweed, waterlily, elodea, hardstem bullrush, and spikerush are plants associated with wetland areas.

The primary element of wetland habitat is the presence of water on the land for a period of time each year. This allows for natural growth of aquatic vegetation. Marshy areas may include mosaics of open water and emergent vegetation that serves as nesting and feeding areas for waterfowl and other wetland wildlife. Wetland meadows that flood in spring and are dry in summer and fall provide nesting areas for birds and mammals and food for many wildlife species, including deer and elk. Wetland areas attract avian and mammal predators because of the high numbers of other wildlife species that use the habitat. Federal and State laws protect wetland habitat by prohibiting draining and filling. Allowing the vegetation to grow to its full potential is best; thus, practices such as grazing should be avoided in wetland areas. These areas can be enhanced by creating open water areas and nesting islands and by using prescribed burning to create a mosaic of vegetation.

Stream and river habitat consists of the areas where water flows down a channel. It includes instream components such as all sizes of rock fragments and woody debris (logs and brush) that are naturally or artifically placed in the stream or river channel, riparian plant communities, and debris from streamside trees and shrubs.

The elements of stream and river habitat include water flowing in the channel, instream components, and riparian vegetation. The type and amount of instream components occurring naturally in streams and rivers is highly variable. These components affect the velocity and direction of the flow of water and provide cover for aquatic species. Associated riparian habitat helps to maintain the stability of stream and river channels and provides shade and habitat for invertebrates. Suitable enhancement practices for stream and river habitat include maintaining adequate flows for the spawning and rearing of fish. Placement of large logs, root wads, or boulders in the streams can improve the habitat for all species and can influence the flow of water in the channel. Shade can be provided by planting trees and shrubs. Water quality, including regulation of the water temperature, sedimentation, and point and nonpoint toxic waste input, is a concern in stream enhancement.

Agricultural land is used to varying degrees by deer and elk and by pheasant, quail, and various other species of birds. These areas are used mainly as a source of food, although they can also provide valuable cover if properly managed.

Agricultural land provides domestic grains, legumes, and other seed-producing annuals for use as food for wildlife. Grain and seed crops include wheat, barley, oats, rye, millet, and sunflower. Pasture grasses and

legumes include alfalfa, clover, sainfoin, orchardgrass, smooth brome, and tall fescue.

Irrigated pasture and farmed areas can be enhanced as habitat for wildlife by maintaining hedgerows and planting the less productive or nonirrigable areas to cover and forage plants. Resting irrigated pastures on a yearly rotation basis provides cover for nesting and wintering animals.

Farm irrigation ponds can be enhanced for wildlife use by fencing out livestock and planting aquatic vegetation that provides food and cover for nesting. Willow cuttings from nearby watercourses can be planted on the banks of ponds along with other trees and shrubs.

Control of exotic weeds may be needed in areas intensively farmed or in areas used as pasture. Care should be taken to avoid adversely impacting other plant species or wildlife.

Fish and Wildlife Species

The survey area supports a wide variety of fish and wildlife species. Some are year-round residents and others occupy the habitat only seasonally.

General soil map units 1, 2, and 3 support lodgepole pine and ponderosa pine forest habitat. These forests provide habitat for mule deer, elk, bear, rabbits, badgers, raccoons, porcupine, bobcats, and coyotes. Larger birds, such as ruffed grouse, goshawk, red-tailed hawk, and great gray owl, use these areas along with black-backed, hairy, and downy woodpeckers and other cavity-dependent birds. The riverine areas in these units provide habitat for rainbow trout, brown trout, whitefish, brook trout, and tui chub. Osprey, kingfishers, mergansers, mallards, and Canada geese nest along the rivers. Mink, beaver, otter, muskrat, and a variety of riparian-dependent passerine birds, smaller mammals, and invertebrates also use these areas. Garter snakes and several species of amphibians live in the areas associated with water.

General soil map units 11, 12, and 13 support drier juniper woodland and sagebrush steppe rangeland habitat. The nonforested rangeland provides habitat for mule deer, coyotes, sage grouse, badgers, antelope, golden eagle, prairie falcon, American kestrel, red-tailed hawk, Swainson's hawk, and ferrugenous hawk. Marmots, Beldings ground squirrel, brush rabbit, Nuttall cottontail, and black-tailed jackrabbit also use this habitat. Sage thrasher, sage sparrow, western meadowlark, Brewer's sparrow, and mountain bluebird are some smaller birds that use these areas.

General soil map units 19 and 20 support plant communities that are dominantly ponderosa pine, manzanita, and bitterbrush. Mule deer, elk, cougars, bear, coyotes, and badgers are the larger animals that use these areas. Golden eagle, bald eagle, goshawk, red-tailed hawk, great horned owl, flammulated owl, and screech owl are some of the avian predators that use these areas as habitat. Quail; ruffed grouse; white-headed, hairy, and downy woodpeckers; and many other small birds inhabit areas of these units. Merriam and Rio Grande turkeys are game birds that have been introduced into these units.

General soil map units 15 and 16 support East Cascade Range middle elevation forests. The western areas support mixed conifer habitat, and the lower lying eastern areas support ponderosa pine and bitterbrush plant communities. Wildlife that use areas dominated by conifers include summer-ranging mule deer, elk, black bear, and cougar. Pine marten, badgers, ground squirrels, chipmunks, and a variety of mice, voles, and shrews also use these areas. Raptors including spotted owl, great horned owl, screech owl, flammulated owl, bald eagle, and goshawk use these forested areas. Ruffed grouse, California quail, and introduced turkeys are larger ground birds found in these areas. Chipping sparrow, green-tailed towhee, winter wren, yellow-rumped warbler, red-breasted and white-breasted nuthatches, and a wide variety of other small birds use the habitat in these units. The streams and rivers provide habitat for bull trout, rainbow trout, brown trout, and whitefish. Raccoon, mink, beaver, river otter, and many species of birds use the associated riparian areas.

General soil map units 5, 6, and 17 support western juniper woodland that includes antelope bitterbrush. Progressively lesser amounts of bitterbrush and higher amounts of big sagebrush are present toward the east in these units. The vegetation associated with these units provides habitat for bobcats, coyotes, mule deer, badgers, porcupine, and a number of other smaller mammals. Townsend's solitaire, black-billed magpie, California quail, northern flicker, mourning dove, mountain bluebird, and dark-eyed junco are a few of the birds in these areas. The Deschutes River corridor provides habitat for rainbow trout, brown trout, whitefish, and tui chub. Avifauna using the habitat associated with the river include golden eagle, bald eagle, osprey, Canada geese, mergansers, mallards, American dipper, yellow warbler, MacGillvary warbler, and rock and canyon wrens. These areas provide winter range for mule deer, although wintering herds have declined as a result of human pressure such as urban growth. Irrigation canals and ponds provide nesting areas for mallards, Brewer's and red-winged blackbirds, tree frogs, western spadefoot toad, and garter snakes.

General soil map units 4, 7, 8, 9, and 10 support areas of western juniper, bitterbrush, and bunchgrass

interspersed with scabland buckwheat flats. Portions of these units have been converted to farmland and pastures. West of the Deschutes River is important winter range for mule deer. Bobcats, coyotes, and a number of burrowing mammals also live in areas of these units. Golden eagle, red-tailed hawk, northern harrier, kestrels, and shrikes are resident raptors. Townsend's solitaire, northern flicker, mountain bluebird, and mountain chickadee are a few of the smaller birds in these areas. Irrigation canals and ponds provide habitat for mallards, Brewer's and red-winged blackbirds, tree frogs, western spadefoot toad, and garter snakes.

General soil map units 14 and 18 support areas of ponderosa pine and bitterbrush, which provide transitory range for herds of Cascade mule deer moving to and from eastern wintering areas. Coyotes, bobcats, marmots, badgers, and rabbits are other mammals that use these areas of ponderosa pine and bitterbrush. Goshawk, red-tailed hawk, Cooper's hawk, flammulated owl, white-headed and black-backed woodpeckers, green-tailed and rufous-sided towhees, Oregon junco, winter wren, chipping sparrow, and yellow-rumped warbler are some of the birds found in these areas.

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 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so

difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, 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 and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, 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.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

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.

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

The table gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation 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 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

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

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help 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 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised

structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, and sulfur. Availability of drainage outlets is not considered in the ratings.

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

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to 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 data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 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 *(4, 16)* and the system adopted by the American Association of State Highway and Transportation Officials *(3, 16)*.

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 larger than 10 inches in diameter and 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 laboratory tests of soils sampled in the survey area

and in nearby areas and on estimates made in the field.

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

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

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, 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. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

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. Swelling was estimated on the basis of the kind and amount of clay minerals in the soil.

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

Hydrologic soil groups are 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.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

The table gives the estimated frequency of flooding. It is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of flooding is more than 50 percent in any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each

soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on observations of the water table at selected sites and on the evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. Indicated in the table are the depth to the seasonal high water table; the kind of water table—that is, perched, apparent, or artesian; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in the table.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone. An *artesian* water table is under hydrostatic head, generally below an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Two numbers in the column showing depth to the water table indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. “More than 6.0” indicates that the water table is below a depth of 6 feet or that it is within a depth of 6 feet for less than a month.

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.

A *cemented pan* is a cemented or indurated subsurface layer within a depth of 5 feet. Such a pan causes difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in 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 *(25, 26)*. 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 18 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 Andisol.

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 Xerand (*Xer*, meaning dry, plus *and*, from Andisol).

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 Vitrixerands (*Vitri*, meaning glass, plus *xerand*, the suborder of the Andisols 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 Vitrixerands. An example of an intergrade subgroup is Humic Vitrixerands. The adjective *Humic*, meaning humus, indicates that the surface layer is enriched with organic matter.

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 ashy over loamy, mixed, frigid Humic Vitrixerands.

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.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(22)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(25)* and in "Keys to Soil Taxonomy" *(26)*. Unless otherwise indicated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Agency Series

The Agency series consists of moderately deep, well drained soils on lava plains and hills. These soils formed in loess over volcaniclastic sediment of the Deschutes Formation. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Agency loam, 0 to 3 percent slopes; 1,500 feet south and 600 feet west of the southeast corner of the NE1/4 of sec. 26, T. 9 S., R. 13 E.

Ap1—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine interstitial pores; neutral (pH 6.8); clear wavy boundary.

Ap2—4 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many very fine tubular pores; neutral (pH 6.8); clear wavy boundary.

AB—8 to 16 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many very fine tubular pores; mildly alkaline (pH 7.6); clear wavy boundary.

Bw1—16 to 24 inches; pale brown (10YR 6/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many very fine tubular pores; mildly alkaline (pH 7.6); gradual wavy boundary.

Bw2—24 to 29 inches; pale brown (10YR 6/3) cobbly loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; hard, friable, slightly sticky and nonplastic; many very fine interstitial pores; 5 percent gravel and 10 percent cobbles; coatings of lime on underside of gravel and cobbles; moderately alkaline (pH 8.0); clear wavy boundary.

2Crkq—29 to 33 inches; weathered tuff with coatings of silica and calcium carbonate along fractures; moderately effervescent; clear wavy boundary.

2R—33 inches; welded tuff of the Deschutes Formation.

Depth to bedrock, consisting of basalt or tuff, is 22 to 40 inches. The particle-size control section averages 18 to 27 percent clay.

The A horizon has hue of 10YR, value of 5 when dry and 3 when moist, and chroma of 2 or 3 when moist or dry. The horizon is sandy loam or loam. It is neutral or mildly alkaline.

The Bw horizon has hue of 10YR, value of 6 when dry and 3 or 4 when moist, and chroma of 3 or 4 when moist or dry. The horizon is loam, clay loam, cobbly loam, or cobbly clay loam and is 15 to 30 percent clay. It is 0 to 20 percent gravel and 0 to 25 percent cobbles. Total rock fragment content is 5 to 30 percent. The horizon is mildly alkaline or moderately alkaline.

The 2Crkq horizon, where present, is weathered tuff of the Deschutes Formation.

Allingham Series

The Allingham series consists of well drained soils that are moderately deep to glacial outwash. These soils are on outwash plains. They formed in ash over glacial outwash. Slopes are 0 to 30 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Allingham gravelly sandy loam in an area of Allingham-Circle complex, 0 to 15 percent slopes; 50 feet south of Forest Service Road 1425, opposite intersection of Forest Service Road 600; in the SW1/4SW1/4 of sec. 33, T. 12 S., R. 9 E.

Oi—1 inch to 0; litter of needles, leaves, and twigs from ponderosa pine, antelope bitterbrush, and manzanita.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; few medium roots and common very fine and fine roots; many very fine interstitial pores and many fine vesicular pores; 20 percent rounded gravel; slightly acid (pH 6.1); gradual smooth boundary.

A2—4 to 8 inches; dark brown (10YR 3/3) gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots and common very fine roots; common very fine interstitial pores and common fine vesicular pores; 20 percent rounded gravel; slightly acid (pH 6.4); gradual wavy boundary.

A3—8 to 16 inches; dark brown (10YR 3/3) gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; common very fine interstitial pores and few fine vesicular pores; 20 percent rounded gravel; neutral (pH 6.6); clear irregular boundary.

2Bwb—16 to 28 inches; dark brown (7.5YR 3/4) loam, yellowish brown (10YR 5/6) dry; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine interstitial pores; 10 percent rounded gravel; neutral (pH 7.0); clear wavy boundary.

3Btb1—28 to 42 inches; dark yellowish brown (10YR 3/6) very gravelly clay loam, yellowish brown (10YR 5/4) dry; weak very coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; many very fine interstitial pores; common iron and manganese coatings on peds; common faint clay films on peds and in pores; 30 percent rounded gravel and 10 percent rounded cobbles; neutral (pH 7.0); gradual wavy boundary.

3Btb2—42 to 65 inches; dark yellowish brown (10YR 3/6) very cobbly clay loam, dark yellowish brown (10YR 3/6) dry; weak very coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine interstitial pores; common faint clay films on peds and in pores; 20 percent rounded gravel and 30 percent rounded cobbles; neutral (pH 6.8).

Depth to the buried glacial outwash material (3Btb horizon) is 20 to 40 inches. Depth to bedrock is more than 60 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. The horizon is 5 to 15 percent clay and 15 to 30 percent rounded gravel. It is slightly acid or neutral.

The 2Bwb horizon has hue of 7.5YR or 10YR when moist and 10YR when dry, value of 3 when moist and 5 when dry, and chroma of 3 or 4 when moist and 6 when dry. The horizon is 15 to 27 percent clay and 5 to 15 percent rounded gravel. It is slightly acid or neutral.

The 3Btb horizon has hue of 10YR when moist or dry, value of 3 when moist and 3 to 5 when dry, and chroma of 6 when moist and 4 to 6 when dry. The horizon is very gravelly and very cobbly loam or clay loam. It is 20 to 35 percent clay. It is 15 to 30 percent rounded gravel and 10 to 35 percent rounded cobbles. Total rock fragment content is 35 to 60 percent. The horizon is neutral or mildly alkaline.

Aquolls

Aquolls consist of very deep, poorly drained soils in basins. These soils formed in lacustrine sediment. Slopes are 0 to 1 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Representative pedon of Aquolls, 0 to 1 percent slopes; 1,000 feet east and 20 feet north of the southwest corner of sec. 21, T. 13 S., R. 11 E.

A1—0 to 3 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak thin platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine interstitial pores; neutral (pH 7.0); clear smooth boundary.

A2—3 to 11 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, sticky and slightly plastic; common very fine roots; many very fine interstitial pores; neutral (pH 7.2); clear wavy boundary.

2C1—11 to 20 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; few distinct dark yellowish brown (10YR 4/4 and 4/6) mottles; massive; slightly hard, firm, sticky and nonplastic; few medium roots; many fine interstitial pores; few iron concretions; neutral (pH 7.2); clear smooth boundary.

3C2—20 to 60 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common distinct grayish brown (10YR 5/2) mottles; massive; hard, very firm, sticky and plastic; few fine tubular pores; neutral (pH 7.2).

Depth to bedrock is more than 60 inches.

The A horizon has value of 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry.

The 2C horizon has value of 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry. The horizon is silt loam or silty clay loam.

The 3C horizon has chroma of 1 to 3 when moist or dry. It is silty clay or silty clay loam.

Bakeoven Series

The Bakeoven series consists of very shallow, well drained soils on hills and lava plains. These soils formed in residuum. Slopes are 0 to 3 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Bakeoven very cobbly loam in area of Bakeoven-Agency-Madras complex, 0 to 3 percent slopes; 200 feet west and 200 feet south of the northeast corner of sec. 25, T. 12 S., R. 11 E.

A—0 to 2 inches; brown (10YR 5/3) very cobbly loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many very fine and few fine vesicular pores; 10 percent gravel, 30 percent cobbles, and 15 percent stones; neutral (pH 7.2); clear smooth boundary.

Bw1—2 to 5 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak thin platy structure; slightly hard, very friable, slightly sticky

and nonplastic; few very fine roots; many very fine interstitial pores; 40 percent gravel; mildly alkaline (pH 7.4); clear wavy boundary.

Bw2—5 to 6 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine, fine, and medium roots; many very fine interstitial pores; 45 percent gravel; mildly alkaline (pH 7.4); clear wavy boundary.

2R—6 inches; basalt.

Depth to bedrock is 4 to 10 inches. The profile is neutral or mildly alkaline.

The A horizon has value 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is 0 to 20 percent gravel, 30 to 50 percent cobbles, and 0 to 15 percent stones. Total rock fragment content is 35 to 60 percent.

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

Beden Series

The Beden series consists of shallow, well drained soils on lava plains and hills. These soils formed in residuum derived from basalt with ash in the upper part. Slopes are 0 to 50 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Beden stony sandy loam, 0 to 10 percent slopes; about 300 feet west and 300 feet south of the northeast corner of sec. 7, T. 22 S., R. 19 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) stony sandy loam, grayish brown (10YR 3/2) dry; weak medium platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many fine vesicular pores; 5 percent gravel, 5 percent cobbles, and 10 percent stones; neutral (pH 7.0); clear wavy boundary.

A2—5 to 11 inches; dark brown (10YR 3/3) stony sandy loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and nonplastic; common very fine, fine, and medium roots; few very fine and fine tubular pores; 5 percent gravel, 5 percent cobbles, and 10 percent stones; neutral (pH 7.2); clear wavy boundary.

2Bt1—11 to 15 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; few very fine tubular pores; few faint clay films on faces of peds and in pores; 10 percent gravel; mildly alkaline (pH 7.4); abrupt wavy boundary.

2Bt2—15 to 18 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, very firm, sticky and plastic; few fine and medium roots; few very fine tubular pores; common faint clay films on faces of peds and in pores; 10 percent gravel; mildly alkaline (pH 7.6); abrupt wavy boundary.

2R—18 inches; fractured basalt with a thin, discontinuous coating of opal on the surface.

Depth to bedrock is 10 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 sandy loam or stony sandy loam and is 5 to 15 percent clay. It is 0 to 15 percent gravel and 0 to 15 percent cobbles and stones. The horizon is 5 to 20 percent volcanic ash.

The 2Bt 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. It is loam, clay loam, gravelly loam, or gravelly clay loam and is 18 to 35 percent clay. The horizon is 5 to 25 percent gravel and 0 to 10 percent cobbles. It is neutral or mildly alkaline.

Belrick Series

The Belrick series consists of very deep, well drained soils on moraines. These soils formed in ash over glacial till. Slopes are 0 to 50 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Belrick fine sandy loam, 15 to 30 percent slopes, on Forest Service Road 1210-300; 100 feet east and 500 feet north of the northwest corner of the SW$^1/_4$ of sec. 14, T. 13 S., R. 8 E.

Oi—1 inch to 0; litter of Douglas fir, white fir, and ponderosa pine needles and twigs and vine maple leaves.

A1—0 to 3 inches; very dark brown (10YR 2/2) fine sandy loam, dark brown (10YR 3/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine interstitial pores; 2 percent subrounded gravel; neutral (pH 6.8); clear wavy boundary.

A2—3 to 11 inches; very dark brown (10YR 2/2) fine sandy loam, dark yellowish brown (10YR 4/4) dry; weak medium granular structure; slightly hard, friable, nonsticky and nonplastic; few medium and

coarse roots and common very fine and fine roots; many very fine interstitial pores; neutral (pH 6.8); gradual wavy boundary.

A3—11 to 16 inches; very dark brown (10YR 2/2) fine sandy loam, dark yellowish brown (10YR 3/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, medium, and coarse roots; many very fine interstitial pores; neutral (pH 7.2); gradual irregular boundary.

2C—16 to 24 inches; mixed black and very dark brown (10YR 2/1 and 2/2) loamy fine sand and fine sand, very dark grayish brown and dark brown (10YR 3/2 and 3/3) dry; massive; loose, nonsticky and nonplastic; few very fine, fine, medium, and coarse roots; many very fine interstitial pores; few weakly cemented nodules; neutral (pH 7.2); clear wavy boundary.

3Bwb—24 to 65 inches; dark yellowish brown (10YR 3/4) extremely stony sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few fine, medium, and coarse roots; many fine interstitial pores and few fine and medium tubular pores; 15 percent subrounded gravel, 20 percent subrounded cobbles, and 30 percent subrounded stones; neutral (pH 7.2).

Depth to the buried glacial till material (3Bwb horizon) is 20 to 40 inches. Depth to bedrock is more than 60 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. The horizon is 5 to 15 percent clay and 0 to 5 percent subrounded gravel. It is slightly acid or neutral.

The 2C horizon has hue of 10YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 or 2 when moist and 2 to 4 when dry. The horizon is mixed or stratified loamy fine sand and fine sand or is fine sandy loam. It is 5 to 15 percent clay and 0 to 5 percent subrounded gravel. The horizon is slightly acid or neutral. It has a layer of black scoria is in some pedons.

The 3Bwb horizon has hue of 10YR, value of 3 when moist and 4 or 5 when dry, and chroma of 4 when moist or dry. It is very stony or extremely stony loam or sandy loam. The horizon is 10 to 20 percent subrounded gravel, 10 to 20 percent subrounded cobbles, and 15 to 30 percent subrounded stones. Total rock fragment content is 35 to 70 percent. The horizon is 10 to 25 percent clay.

Blayden Series

The Blayden series consists of well drained soils that are shallow to a duripan. These soils are on lava plains. They formed in old alluvium capped with ash. Slopes are 0 to 3 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Blayden loamy sand, 0 to 3 percent slopes; about 300 feet south and 300 feet west of the northeast corner of the SE$^1/_4$ of sec. 5, T. 20 S., R. 16 E.

A1—0 to 3 inches; grayish brown (10YR 5/2) loamy sand, dark brown (10YR 3/3) moist; moderate thick platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine vesicular pores; 5 percent gravel; neutral (pH 7.2); clear wavy boundary.

2A2—3 to 7 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; many very fine tubular pores; 20 percent gravel; mildly alkaline (pH 7.6); clear smooth boundary.

2Bt—7 to 15 inches; pale brown (10YR 6/3) gravelly loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine tubular pores; few faint clay films on peds and in pores; 30 percent gravel; mildly alkaline (pH 7.8); abrupt smooth boundary.

3Bkqm—15 to 60 inches; pale brown (10YR 6/3) indurated gravelly duripan, dark yellowish brown (10YR 4/4) moist; carbonates occur as coatings on rock fragments or as filaments; violently effervescent; moderately alkaline (pH 8.0).

Depth to the duripan is 12 to 20 inches. Depth to bedrock is more than 60 inches. The duripan consists of stratified sand and gravel. The mollic epipedon is 7 to 11 inches thick.

The A horizon has value of 3 when moist and 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is 5 to 25 percent gravel. The upper part is 2 to 10 percent clay, and the lower part is 10 to 20 percent clay.

The 2Bt 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 gravelly loam, gravelly clay loam, or gravelly sandy clay loam and is 10 to 35 percent gravel and 25 to 35 percent clay. It is mildly alkaline or moderately alkaline.

Bluesters Series

The Bluesters series consists of excessively drained soils that are shallow to cinders. These soils are on cinder cones. They formed in ash over cinders. Slopes are 15 to 50 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Bluesters gravelly sandy loam, 15 to 50 percent slopes; on the east side of Henkle Butte; 1,000 feet east of the southwest corner of sec. 24, T. 14 S., R. 10 E.

A1—0 to 4 inches; dark brown (10YR 3/3) gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots and many very fine roots; many very fine irregular pores; 20 percent angular gravel; neutral (pH 7.0); gradual wavy boundary.

A2—4 to 16 inches; dark brown (7.5YR 3/2) gravelly sandy loam, brown (7.5YR 5/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots and few fine, medium, and coarse roots; many very fine irregular pores; 30 percent angular gravel; neutral (pH 7.0); clear wavy boundary.

2C—16 to 60 inches; cinders that are black (N 2/0) and dark reddish brown (5YR 3/4) moist or dry; single grain; loose, nonsticky and nonplastic; common very fine roots and few fine, medium, and coarse roots; many fine vesicular pores; less than 10 percent of voids filled; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to cinders is 14 to 30 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 4 when dry. It is 15 to 35 percent basaltic gravel-sized cinders and 20 percent pumice sand (0.5 to 2.0 millimeters).

The 2C horizon has hue of 5YR, 7.5YR, or 10YR or is neutral. It has value of 2, 3, 5, 6, or 7 when moist or dry and chroma of 0, 4, or 8 when moist or dry. The horizon is 80 to 100 percent gravel-sized cinders.

Borobey Series

The Borobey series consists of very deep and deep, somewhat excessively drained soils on lava plains. These soils formed in ash over old alluvium. Slopes are 0 to 5 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Borobey sandy loam, 0 to 5 percent slopes; 900 feet south of U.S. Highway 20, in the $NW^1/_4NW^1/_4NW^1/_4$ of sec. 12, T. 20 S., R. 16 E.

A—0 to 4 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many fine and medium irregular pores; about 30 percent ash; neutral; clear smooth boundary.

AB—4 to 21 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, slightly sticky and nonplastic; common very fine roots; many fine and medium irregular pores; about 40 percent ash; neutral; clear wavy boundary.

Bq—21 to 51 inches; pale brown (10YR 6/3) sandy loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; hard, firm and brittle, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; about 40 percent ash; neutral; abrupt smooth boundary.

2Bwb—51 to 60 inches; pale brown (10YR 6/3) clay loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; neutral.

Depth to the brittle layer is 20 to 40 inches. Depth to bedrock is more than 60 inches. Depth to a strongly cemented or indurated duripan is 40 to 60 inches or more.

The A and AB horizons have chroma of 2 or 3 when moist or dry. They are 0 to 25 percent gravel. The horizons are sandy loam or gravelly sandy loam with a thin layer of loamy sand in some pedons.

The Bq horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry. The horizon is sandy loam or loamy sand and is 5 to 15 percent clay and 55 to 80 percent sand. It is neutral to moderately alkaline. The horizon is 0 to 25 percent gravel.

The 2Bwb horizon, where present, is loam or clay loam and is 15 to 30 percent clay. It is neutral to moderately alkaline.

Bott Series

The Bott series consists of very deep, well drained soils on mountains. These soils formed in ash over colluvium. Slopes are 0 to 50 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Bott gravelly sandy loam in an area of Bott-Douthit complex, 15 to 30 percent slopes; on Forest Service Road 1200-860; 300 feet north and 200 feet west of the southeast corner of sec. 7, T. 12 S., R. 9 E.

Oi—1 inch to 0; litter of Douglas fir and white fir needles and twigs.
A1—0 to 10 inches; dark yellowish brown (10YR 3/4) gravelly sandy loam, yellowish brown (10YR 5/4) dry; moderate fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine and fine roots and few medium roots; many very fine irregular pores; 15 percent subrounded gravel; 25 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); gradual wavy boundary.
A2—10 to 23 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure parting to single grain; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine irregular pores; 10 percent subrounded gravel; 20 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); clear wavy boundary.
2Btb—23 to 62 inches; dark brown (10YR 3/3) very stony loam, brown (10YR 5/3) dry; strong fine and medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots and few fine, medium, and coarse roots; common fine vesicular pores and few fine tubular pores; common distinct clay films on peds and in pores; 20 percent subrounded gravel, 10 percent cobbles, and 25 percent subrounded and angular stones; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to the buried soil material is 20 to 30 inches. It is 10 to 20 percent clay.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR or 7.5YR and value of 3 when moist and 5 when dry. The upper part of the horizon has chroma of 4 when moist or dry, and the lower part has chroma of 4 when moist and 5 or 6 when dry. The horizon is 5 to 25 percent gravel. It is sandy loam or gravelly sandy loam.

The 2Btb horizon has hue of 10YR or 7.5YR, value of 3 when moist and 5 when dry, and chroma of 3 or 4 when moist or dry. It is 15 to 25 percent gravel, 5 to 15 percent cobbles, and 15 to 30 percent stones. Total rock fragment content is 35 to 60 percent.

Buckbert Series

The Buckbert series consists of very deep, well drained soils in swales on hills. These soils formed in ash over alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Buckbert sandy loam, 0 to 3 percent slopes; 1,000 feet south and 100 feet west of the northeast corner of the NW1/4 of sec. 17, T. 14 S., R. 12 E.

Ap—0 to 8 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; neutral (pH 6.8); gradual smooth boundary.
AB—8 to 21 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine irregular pores; neutral (pH 7.2); gradual wavy boundary.
Bw1—21 to 40 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine irregular pores; 5 percent pumice gravel; mildly alkaline (pH 7.6); abrupt wavy boundary.
Bw2—40 to 52 inches; light yellowish brown (10YR 6/4) loam, dark brown (7.5YR 4/4) moist; many medium distinct very dark grayish brown mottles; weak coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; few fine tubular pores; 5 percent pumice gravel; mildly alkaline (pH 7.6); clear wavy boundary.
C—52 to 60 inches; yellowish brown (10YR 5/4) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; few fine tubular pores; mildly alkaline (pH 7.6).

Depth to bedrock is 60 inches or more.

The A and AB horizons have hue of 10YR, value of 2 or 3 when moist and 5 when dry, and chroma of 2 or 3 when moist or dry.

The Bw horizon has hue of 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is 0 to 10 percent gravel-sized pumice and 15 to 25 percent clay.

The C horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist and 4 when dry. It is 0 to 10 percent

gravel-sized pumice. Faint to distinct mottles are in most pedons as a result of irrigation. The horizon is sandy loam or loam and is 10 to 20 percent clay.

Caphealy Series

The Caphealy series consists of moderately deep, well drained soils on hills. These soils formed in colluvium over volcaniclastic sediment of the Deschutes Formation. Slopes are 0 to 30 percent slopes. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Caphealy sandy loam in an area of Caphealy-Reuter complex, 15 to 30 percent slopes; on the east side of roadcut; 200 feet north and 1,000 feet west of the southeast corner of the northwest corner of sec. 36, T. 12 S., R. 12 E.

A1—0 to 2 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine interstitial pores; 5 percent gravel; neutral (pH 7.2); clear smooth boundary.

A2—2 to 16 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine tubular pores; 2 percent gravel; mildly alkaline (pH 7.8); gradual smooth boundary.

Bw—16 to 19 inches; brown (10YR 5/3) coarse sandy loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; 10 percent gravel; moderately alkaline (pH 8.0); clear smooth boundary.

2Bk—19 to 23 inches; brown (10YR 5/3) gravelly coarse sand, dark yellowish brown (10YR 3/4) moist; single grain; loose, nonsticky and nonplastic; many very fine interstitial pores; 30 percent gravel; coatings of calcium carbonate on underside of coarse fragments; moderately alkaline (pH 8.0); gradual broken boundary.

3Crkq—23 to 26 inches; weathered, fractured tuff with discontinuous veins of silica and calcium carbonate; clear wavy boundary.

3R—26 inches; welded tuff of the Deschutes Formation.

The paralithic contact is at a depth of 20 to 38 inches, and it is underlain by hard bedrock. The profile is 10 to 25 percent pumice sand throughout.

The A horizon has hue of 10YR, value of 5 when dry and 2 or 3 when moist, and chroma of 2 or 3 when moist or dry. It is 0 to 10 percent gravel. The horizon is neutral or mildly alkaline.

The Bw horizon has hue of 10YR, value of 5 or 6 when dry and 3 when moist, and chroma of 3 or 4 when dry and 4 when moist. It is sandy loam or coarse sandy loam and is 0 to 15 percent gravel.

The 2Bk horizon, where present, has hue of 10YR, value of 5 or 6 when dry and 3 when moist, and chroma of 3 or 4 when dry and 4 when moist. It is 15 to 35 percent gravel. Secondary carbonate accumulation occurs as coatings on rock fragments and as free carbonates in matrix.

Choptie Series

The Choptie series consists of shallow, well drained soils on lava plains and hills. These soils formed in colluvium and residuum derived from welded tuff and basalt with ash in the upper part. Slopes are 5 to 20 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Choptie loam in an area of Choptie-Westbutte complex, 5 to 20 percent slopes; 300 feet west and 300 feet south of the northeast corner of sec. 24, T. 21 S., R. 20 E.

A—0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine vesicular pores; 5 percent gravel; neutral (pH 6.8); clear wavy boundary.

AB—5 to 15 inches; brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and medium roots; common very fine and fine tubular pores; 5 percent gravel and 5 percent cobbles; neutral (pH 6.8); clear wavy boundary.

Bw—15 to 19 inches; brown (10YR 5/3) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular pores; 30

percent gravel; neutral (pH 7.0); abrupt wavy boundary.
R—19 inches; welded tuff.

Depth to bedrock is 10 to 20 inches. The profile is slightly acid or neutral.

The A and AB horizons have value of 2 or 3 when moist and 4 or 5 when dry, and they have 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 sandy loam, loam, or gravelly loam and is 12 to 18 percent clay.

Circle Series

The Circle series consists of well drained soils that are deep to glacial outwash. These soils are on outwash plains. They formed in ash over glacial outwash. Slopes are 0 to 30 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Circle sandy loam in an area of Allingham-Circle complex, 0 to 15 percent slopes; 1.2 miles on Forest Service Road 200 from Forest Service Road 1230; in the NW$^1/_4$SE$^1/_4$ of sec. 29, T. 12 S., R. 9 E.

Oi—1 inch to 0; litter of ponderosa pine needles and antelope bitterbrush leaves and twigs.
A1—0 to 3 inches; dark brown (10YR 3/3) sandy loam, dark yellowish brown (10YR 4/4) dry; moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and few fine roots; many very fine interstitial pores; 2 percent rounded gravel; neutral (pH 7.2); gradual wavy boundary.
A2—3 to 16 inches; dark brown (10YR 3/3) sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots and few fine, medium, and coarse roots; many very fine interstitial pores; 2 percent rounded gravel; neutral (pH 7.2); gradual wavy boundary.
2Bwb1—16 to 28 inches; dark brown (7.5YR 3/4) loam, dark yellowish brown (10YR 4/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; common very fine interstitial and vesicular pores and few fine tubular pores; 5 percent rounded gravel; neutral (pH 7.0); clear irregular boundary.
2Bwb2—28 to 42 inches; dark yellowish brown (10YR 3/4) gravelly loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine, medium, and coarse roots; common fine vesicular pores and common medium tubular pores; 25 percent rounded gravel; neutral (pH 7.0); gradual wavy boundary.
3Btb3—42 to 65 inches; dark yellowish brown (10YR 3/4) very gravelly clay loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine, medium, and coarse roots; common fine vesicular pores and common medium tubular pores; few faint clay films on peds; 40 percent rounded gravel and 10 percent rounded cobbles that are 8 to 13 centimeters in diameter; neutral (pH 7.0).

Depth to the buried glacial outwash material (3Btb horizon) is 40 to 50 inches. Depth to bedrock is more than 60 inches. The profile is slightly acid or neutral.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry. The horizon is 5 to 15 percent clay. It is 0 to 10 percent rounded gravel.

The 2Bwb horizon is 15 to 27 percent clay and 0 to 25 percent rounded gravel.

The 3Btb horizon is 27 to 35 percent clay. It is 30 to 50 percent rounded gravel and 5 to 15 percent rounded cobbles. Total rock fragment content is 35 to 60 percent.

Clinefalls Series

The Clinefalls series consists of very deep, well drained soils on stream terraces. These soils formed in ash over alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Clinefalls sandy loam, 0 to 3 percent slopes; 1,600 feet south and 150 feet east of the northwest corner of sec. 26, T. 14 S., R. 12 E.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; 5 percent gravel; neutral (pH 6.8); clear smooth boundary.
A2—5 to 15 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure parting to granular; slightly hard, friable, nonsticky

and nonplastic; common very fine and fine roots; many very fine irregular pores; 10 percent gravel; neutral (pH 6.8); clear wavy boundary.

Bw—15 to 20 inches; grayish brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine irregular pores; 15 percent gravel; neutral (pH 7.0); clear wavy boundary.

BC—20 to 25 inches; brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine irregular pores; 35 percent gravel; neutral (pH 7.2); gradual wavy boundary.

2C1—25 to 41 inches; dark gray (10YR 4/1) and white (10YR 8/2) extremely gravelly sand, black (10YR 2/1) and very pale brown (10YR 7/3) moist; single grain; loose, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; 65 percent gravel; mildly alkaline (pH 7.4); abrupt smooth boundary.

3C2—41 to 50 inches; dark gray (10YR 4/1) sand, black (10YR 2/1) moist; single grain; loose, nonsticky and nonplastic; many fine irregular pores; 5 percent gravel; mildly alkaline (pH 7.4); abrupt smooth boundary.

4C3—50 to 60 inches; white (10YR 8/2) extremely gravelly sand, pale brown (10YR 7/3) moist; single grain; loose, nonsticky and nonplastic; many fine irregular pores; 70 percent gravel; mildly alkaline (pH 7.6).

Depth to bedrock is more than 60 inches. Depth to stratified sand and gravel is 20 to 40 inches.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 or 2 when moist or dry. It is 5 to 15 percent gravel.

The Bw and BC horizons have value of 4 or 5 when dry and 2 or 3 when moist, and they have chroma of 2 or 3 when moist or dry. These horizons are 15 to 45 percent gravel.

The C horizon has value of 4 to 8 when dry and 2 to 7 when moist, and it has chroma of 1 to 3 when moist or dry. The horizon is 5 to 70 percent gravel and 0 to 20 percent cobbles. It is stratified sand and gravel with some cobbles. The horizon is neutral or mildly alkaline.

Clovkamp Series

The Clovkamp series consists of deep and very deep, somewhat excessively drained soils on old stream terraces on lava plains. These soils formed in ash over gravelly alluvium. Slopes are 0 to 25 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Clovkamp loamy sand, 0 to 3 percent slopes; 1,300 feet south and 1,200 feet east of the northwest corner of the NW$^{1}/_{4}$ of sec. 8, T. 18 S., R. 14 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 10 percent gravel; 50 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); abrupt smooth boundary.

A2—4 to 12 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; 10 percent gravel; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); clear smooth boundary.

C—12 to 24 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 10 percent gravel; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.2); gradual wavy boundary.

2Bqb—24 to 40 inches; pale brown (10YR 6/3) gravelly loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; hard, firm and brittle, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 20 percent gravel; mildly alkaline (pH 7.6); abrupt wavy boundary.

2Bkqb—40 to 50 inches; pale brown (10YR 6/3) extremely gravelly sand, dark grayish brown (10YR 4/2) moist; massive; very hard, very firm and brittle, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 65 percent gravel; thin slightly effervescent cap of carbonates at a depth of 40 inches and coatings of carbonates on underside of gravel; mildly alkaline (pH 7.6); abrupt wavy boundary.

2Bkb—50 to 60 inches; pale brown (10YR 6/3)

extremely gravelly sand, dark grayish brown (10YR 4/2) moist; single grain; loose, nonsticky and nonplastic; many fine interstitial pores; 80 percent gravel; slightly effervescent; mildly alkaline (pH 7.8).

Depth to bedrock is 40 to 60 inches or more. Depth to the brittle layer is 20 to 40 inches. Depth to carbonates and to the extremely gravelly layer is 35 to 50 inches.

The A horizon has value of 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is 40 to 70 percent pumice (0.5 to 2.0 millimeters).

The C horizon has value of 5 or 6 when dry and 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is 20 to 50 percent pumice (0.5 to 2.0 millimeters). The horizon is 0 to 10 percent basalt gravel and 0 to 10 percent cobbles. Total rock fragment content is 0 to 15 percent. The horizon is neutral or mildly alkaline.

The 2Bqb horizon has value of 5 or 6 when dry and 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is hard and brittle throughout. It is gravelly loamy fine sand or loamy sand and is 15 to 25 percent gravel.

The 2Bkqb horizon has value of 5 or 6 when dry and 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is extremely gravelly sand or loamy sand and is 65 to 85 percent gravel. It is very hard and brittle throughout. Carbonates occur as a thin layer or as coatings on the underside of gravel.

The 2Bkb horizon, where present, has value of 5 or 6 when dry and 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is extremely gravelly sand or loamy sand and is 65 to 90 percent gravel. Coatings of carbonates are on the underside of gravel.

Cryaquolls

Cryaquolls consist of very deep, very poorly drained and poorly drained soils on pumice-mantled flood plains. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is 20 inches, and the mean annual air temperature is 43 degrees F.

Representative pedon of Cryaquolls, 0 to 3 percent slopes, in the NW¼NE¼ of sec. 3, T. 21 S., R. 10 E.

Oi—1 inch to 0; litter from tussock grasses and willow.
A—0 to 2 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine, fine, and medium roots; many very fine vesicular pores; moderately acid (pH 6.0); abrupt smooth boundary.
2Ab1—2 to 14 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; common fine distinct mottles that are reddish brown (5YR 4/4) when moist; moderate very fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine, fine, and medium roots; many very fine vesicular pores; neutral (pH 6.6); abrupt smooth boundary.
2Ab2—14 to 18 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 5/1) dry; common fine distinct mottles that are reddish brown (5YR 4/4) when moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine vesicular pores; neutral (pH 6.6); abrupt smooth boundary.
2AC—18 to 22 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine vesicular pores; neutral (pH 6.6); abrupt smooth boundary.
3C—22 to 60 inches; very dark gray (10YR 3/1) sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine vesicular pores; slightly acid (pH 6.4).

The water table is at the surface to a depth of 24 inches from November to August. Depth to bedrock is more than 60 inches. Layers of diatomaceous earth are in the profile in some areas. The mollic epipedon is 15 to 30 inches thick.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has value of 4 or 5 when moist and 6 or 7 when dry.

The 2Ab horizon has value of 2 or 3 when moist and 4 or 5 when dry. The horizon is sandy loam, loam, silt loam, or loamy sand.

Color of the 3C horizon is variable. The horizon is sand, loamy sand, or sandy loam. It is slightly acid or neutral.

Cullius Series

The Cullius series consists of shallow, well drained soils on lava plains and hills. These soils formed in loess over colluvium underlain by volcaniclastic sediment of the Deschutes Formation. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Cullius loam, 3 to 8 percent slopes; 500 feet north and 500 feet west of the southeast corner of the SW¼ of sec. 17, T. 12 S., R. 13 E.

Ap—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; neutral (pH 7.2); abrupt smooth boundary.

A—3 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; neutral (pH 7.3); clear wavy boundary.

2Bt1—6 to 9 inches; grayish brown (10YR 5/2) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, firm, nonsticky and slightly plastic; few fine roots; many very fine tubular pores; few faint clay films in pores and on faces of peds; 30 percent clay; 10 percent gravel; mildly alkaline (pH 7.4); clear wavy boundary.

2Bt2—9 to 17 inches; grayish brown (10YR 5/2) clay, dark yellowish brown (10YR 3/4) moist; moderate coarse prismatic structure; hard, firm, sticky and plastic; few very fine tubular pores; many prominent clay films in pores and on faces of peds; 60 percent clay; 10 percent cobbles; mildly alkaline (pH 7.8); abrupt smooth boundary.

2Crkq—17 to 18 inches; weathered, fractured tuff; common medium discontinuous veins of silica and calcium carbonate; effervescent; clear wavy boundary.

2R—18 inches; welded tuff of the Deschutes Formation.

Thickness of the solum and depth to bedrock are 10 to 20 inches.

The A horizon has hue of 10YR, value of 5 when dry and 2 or 3 when moist, and chroma of 2 or 3 when moist or dry.

The 2Bt horizon has hue of 10YR, value of 5 when dry and 3 when moist, and chroma of 2 or 3 when dry and 3 or 4 when moist. It is 0 to 10 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 0 to 10 percent. The lower part of the horizon has medium or coarse prismatic structure.

The 2Crkq horizon has discontinuous silica cementation and secondary carbonates that occur as soft powdery lime and as coatings on the fractured tuff fragments.

Deschutes Series

The Deschutes series consists of moderately deep, well drained soils on lava plains. These soils formed in ash. Slopes are 0 to 30 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Deschutes sandy loam, 0 to 3 percent slopes; 400 feet west and 200 feet south of the northeast corner of the $SE^1/_4SW^1/_4$ of sec. 26, T. 15 S., R. 12 E.

A1—0 to 3 inches; grayish brown (10YR 5/2) sandy loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine and medium roots; many fine interstitial pores; 1 percent subrounded gravel; mildly alkaline (pH 7.6); clear smooth boundary.

A2—3 to 7 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots and few fine and medium roots; common fine interstitial pores; 1 percent subrounded gravel; mildly alkaline (pH 7.6); clear smooth boundary.

A3—7 to 17 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; common fine interstitial pores; 1 percent subrounded gravel; mildly alkaline (pH 7.8); clear smooth boundary.

2Bk—17 to 28 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine, medium, and coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots; few fine interstitial pores; strongly effervescent; 2 percent subrounded gravel; mildly alkaline (pH 7.8); abrupt wavy boundary.

2Bkq—28 to 31 inches; grayish brown (10YR 5/2) and light grayish brown (10YR 6/2) sandy loam, dark brown (10YR 3/3) moist; strong thin platy structure; hard, firm, nonsticky and nonplastic; few fine roots; many medium and coarse tubular pores; very fine concentrations and pseudomycelia of silica and calcium carbonate; mildly alkaline (pH 7.8); abrupt broken boundary.

3R—31 inches; basalt.

Depth to bedrock is 20 to 40 inches. The particle-size control section is 5 to 10 percent clay and 55 to 75 percent sand.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist and 2 to 4 when dry. It is 0 to 5 percent gravel, 0 to 10 percent cobbles, and 0 to 5 percent stones. Total rock

fragment content is 0 to 10 percent. The horizon is neutral or mildly alkaline.

The 2B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 to 4 when moist or dry. It is 0 to 5 percent gravel, 0 to 10 percent cobbles, and 0 to 5 percent stones. Total rock fragment content is 0 to 20 percent. The horizon is sandy loam or gravelly sandy loam. It is 0 to 15 percent durinodes. Thin coatings of lime are on rock fragments and durinodes.

Deskamp Series

The Deskamp series consists of moderately deep, somewhat excessively drained soils on lava plains. These soils formed in ash. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Deskamp loamy sand in an area of Deskamp-Gosney complex, 0 to 8 percent slopes; 100 feet west and 50 feet south of the northeast corner of sec. 15, T. 18 S., R. 12 E.

A1—0 to 4 inches; brown (10YR 4/3) loamy sand, dark brown (10YR 3/3) moist; single grain; loose, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.0); clear smooth boundary.

A2—4 to 10 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) moist; weak fine and medium subangular structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; neutral (pH 7.0); clear smooth boundary.

AC—10 to 17 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic, common very fine and fine roots; many very fine interstitial pores; neutral (pH 7.2); clear wavy boundary.

2Cq1—17 to 25 inches; pale brown (10YR 6/3) gravelly loamy sand, dark brown (10YR 4/3) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 5 percent weakly cemented nodules that are hard when dry and friable when moist; 20 percent gravel; mildly alkaline (pH 7.4); clear wavy boundary.

2Cq2—25 to 32 inches; pale brown (10YR 6/3) gravelly loamy sand, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine interstitial pores; 10 percent weakly cemented nodules; 25 percent gravel; mildly alkaline (pH 7.4); abrupt wavy boundary.

3R—32 inches; basalt.

Depth to bedrock is 20 to 40 inches.

The A and AC horizons have value of 4 or 5 when dry and 2 or 3 when moist, and they have chroma of 2 or 3 when dry and 1 to 3 when moist. The horizons are loamy sand or sandy loam and are 0 to 5 percent gravel.

The 2C horizon is loamy sand or gravelly loamy sand. It is 10 to 25 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 10 to 30 percent. The horizon is 0 to 10 percent weakly cemented silica nodules that are friable when moist. It is neutral or mildly alkaline.

Dester Series

The Dester series consists of moderately deep, well drained soils on lava plains. These soils formed in ash over old alluvium. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Dester sandy loam, 0 to 8 percent slopes; in the $SE^1/_4NW^1/_4$ of sec. 1, T. 20 S., R. 17 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium platy structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; many fine and medium irregular pores; neutral (pH 7.0); clear wavy boundary.

A2—4 to 17 inches; grayish brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; many fine and medium irregular pores; neutral (pH 7.0); clear smooth boundary.

2Bt1—17 to 24 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; few faint clay films on peds and in pores; neutral (pH 7.3); clear wavy boundary.

2Bt2—24 to 34 inches; light yellowish brown (10YR 6/4) gravelly clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, very firm, very sticky and very plastic; few fine roots; few very fine tubular pores; 15 percent gravel; effervescent in spots; moderately alkaline (pH 7.9); abrupt wavy boundary.

3R—34 inches; basalt; thin, discontinuous coating of opal on bedrock.

Depth to bedrock is 20 to 40 inches.

The A horizon has chroma of 2 or 3 when dry. The horizon is sandy loam or gravelly loamy sand and is 0 to 20 percent gravel and 5 to 15 percent clay.

The 2Bt horizon has chroma of 2 to 4 when moist or dry. The horizon is gravelly clay loam, sandy clay loam, or clay loam. It is 27 to 35 percent clay and 0 to 25 percent gravel.

Douthit Series

The Douthit series consists of very deep, well drained soils on moraines. These soils formed in ash over glacial till. Slopes are 0 to 50 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Douthit sandy loam, 15 to 30 percent slopes, 1,000 feet north and 200 feet east of the southwest corner of sec. 1, T. 12 S., R. 8 E.

Oi—2 inches to 0; litter of white fir leaves and twigs.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine and medium roots; many very fine irregular pores; 10 percent gravel, 2 percent cobbles, and 2 percent stones; neutral (pH 6.8); gradual wavy boundary.

A2—3 to 12 inches; dark yellowish brown (10YR 3/4) cobbly sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure parting to single grain; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine, medium, and coarse roots; many very fine irregular pores; 15 percent gravel, 10 percent cobbles, and 5 percent stones; neutral (pH 7.0); gradual irregular boundary.

2C1—12 to 52 inches; dark brown (7.5YR 3/4) extremely stony sandy loam, brown (7.5YR 4/4) dry; single grain; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine, medium, and coarse roots; many very fine irregular pores; 25 percent gravel, 20 percent cobbles, and 20 percent stones; neutral (pH 7.0); clear irregular boundary.

2C2—52 to 62 inches; dark yellowish brown (10YR 3/4) extremely stony sandy loam, pale brown (10YR 6/3) dry; single grain; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine, medium, and coarse roots; many fine irregular pores; 25 percent gravel, 20 percent cobbles, and 20 percent stones; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to glacial till is 10 to 20 inches. The profile is 5 to 15 percent clay throughout.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR or 7.5YR, and it has value of 3 when moist and 4 or 5 when dry. The A1 horizon has chroma of 2 or 3 when moist or dry, and the A2 horizon has chroma of 3 or 4 when moist or dry. The A horizon is 10 to 20 percent gravel, 0 to 15 percent cobbles, and 0 to 10 percent stones. Total rock fragment content is 10 to 35 percent.

The 2C horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. It is sandy loam or loamy sand and is 20 to 30 percent gravel, 15 to 25 percent cobbles, and 10 to 20 percent stones. Total rock fragment content is 40 to 70 percent.

Embal Series

The Embal series consists of very deep, well drained soils on flood plains and alluvial fans. These soils formed in recent alluvium that is high in content of volcanic ash. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Embal sandy loam, 0 to 3 percent slopes; $^{3}/_{8}$ mile north of Misery Flat Well; about 150 feet north and 15 feet east of the southwest corner of sec. 2, T. 22 S., R. 22 E.

A1—0 to 2 inches; grayish brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine vesicular pores; 2 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

A2—2 to 10 inches; grayish brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 2 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

A3—10 to 20 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and medium roots; few very fine tubular pores; 2 percent gravel; mildly alkaline; (pH 7.6); clear wavy boundary.

C1—20 to 30 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few

fine and medium roots; few very fine tubular pores; 10 percent gravel; mildly alkaline (pH 7.6); gradual smooth boundary.

C2—30 to 60 inches; grayish brown (10YR 5/3) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; single grain; soft, very friable, nonsticky and nonplastic; few fine and medium roots; common fine irregular pores; 25 percent gravel; mildly alkaline (pH 7.6).

Depth to bedrock is more than 60 inches. The profile is 30 to 50 percent sand-sized pumice ash. The mollic epipedon is 20 to 35 inches thick. The profile is 10 to 18 percent clay throughout.

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

The C horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is sandy loam, loam, or gravelly sandy loam and is 0 to 35 percent gravel. It is mildly alkaline or moderately alkaline.

Era Series

The Era series consists of very deep, well drained soils in swales and on hills. These soils formed in ash over old alluvium. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is 48 degrees F.

Typical pedon of Era sandy loam, cobbly substratum, 0 to 3 percent slopes; 2 miles east of Madras, on Ashwood Road; east of north-south fence line; 50 feet south and 10 feet east of the northwest corner of sec. 8, T. 11 S., R. 14 E.

Ap—0 to 3 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; mildly alkaline (pH 7.6); abrupt smooth boundary.

A—3 to 10 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine tubular pores; mildly alkaline (pH 7.8); clear smooth boundary.

Bw—10 to 28 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine tubular pores; moderately alkaline (pH 8.0); gradual wavy boundary.

Bk1—28 to 36 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; slightly effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk2—36 to 42 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine tubular pores; slightly effervescent; strongly alkaline (pH 8.8); clear wavy boundary.

2Bk3—42 to 60 inches; brown (10YR 5/3) very cobbly sandy loam, dark brown (10YR 3/3) moist; massive; very hard, firm, nonsticky and nonplastic; many very fine interstitial pores; 20 percent gravel and 30 percent cobbles; carbonates in seams and as coatings on rock fragments; strongly effervescent; strongly alkaline (pH 8.8).

Depth to bedrock is more than 60 inches. Depth to secondary carbonates is 30 to 44 inches.

The A horizon has hue of 10YR, value of 5 when dry and 3 when moist, and chroma of 2 or 3 when moist or dry.

The Bw and Bk horizons have hue of 10YR, value of 5 or 6 when dry and 3 when moist, and chroma of 3 or 4 when moist or dry. They are moderately alkaline or strongly alkaline.

The 2Bk horizon has hue of 10YR, value of 5 or 6 when dry and 3 when moist, and chroma of 3 or 4. It is sandy loam, cobbly sandy loam, or very cobbly sandy loam. The horizon is 0 to 25 percent gravel and 0 to 35 percent cobbles. Total rock fragment content is 0 to 40 percent.

The Era soils in this survey area are a taxadjunct to the Era series because the soils are Vitritorrandic. The content of volcanic glass is more than 30 percent throughout, but phosphate retention is less than 25 percent and acid-oxalate aluminum plus one-half the iron is less than 0.4.

Ermabell Series

The Ermabell series consists of very deep, well drained soils on stream terraces. These soils formed in ash over glacial outwash. Slopes are 0 to 3 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Ermabell loamy fine sand, 0 to 3 percent slopes; 0.5 mile south of Sisters, on Three Creeks Road; 100 feet east and 100 feet north of the southwest corner of the northwest corner of sec. 9, T. 15 S., R. 10 E.

A1—0 to 8 inches; very dark brown (10YR 2/2) loamy

fine sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; loose, nonsticky and nonplastic; common very fine and fine roots and few medium and coarse roots; many very fine irregular pores; neutral (pH 7.2); clear smooth boundary.

A2—8 to 17 inches; very dark brown (10YR 2/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine, fine, medium, and coarse roots; common very fine irregular pores; neutral (pH 7.2); clear smooth boundary.

A3—17 to 31 inches; very dark brown (10YR 2/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few medium and coarse roots; common very fine irregular pores; 10 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.2); gradual smooth boundary.

AC—31 to 41 inches; very dark brown (10YR 2/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few fine irregular pores; 15 percent pumice (0.5 to 2.0 millimeters); 5 percent gravel; mildly alkaline (pH 7.6); abrupt wavy boundary.

2C—41 to 60 inches; very dark brown (10YR 2/2) very gravelly sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; 30 percent rounded gravel, 15 percent rounded cobbles, and 5 percent rounded boulders; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Depth to the glacial outwash material (2C horizon) is 40 inches or more. The profile is neutral or mildly alkaline throughout.

The A and AC horizons have hue of 10YR, value of 2 or 3 when moist or dry, and chroma of 2 when moist and 4 or 5 when dry. They are 0 to 5 percent gravel and 5 to 15 percent pumice (0.5 to 2.0 millimeters). The horizons are loamy fine sand, loamy very fine sand, or fine sand and are 2 to 10 percent clay.

The 2C horizon has hue of 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is very gravelly sand or extremely gravelly sand. The horizon is 35 to 60 percent gravel, 5 to 15 percent cobbles, and 0 to 5 percent stones. Total rock fragment content is 45 to 80 percent. The horizon is 1 to 5 percent clay.

Flarm Series

The Flarm series consists of very deep, somewhat poorly drained soils in depressions and swales on mountains. These soils formed in ash over colluvium. Slopes are 0 to 15 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Flarm loam in an area of Flarm-Smiling complex, 0 to 15 percent slopes; 0.2 mile west of the junction of Forest Service Roads 1180 and 1100; 1,000 feet east and 500 feet north of the southwest corner of sec. 2, T. 12 S., R. 10 E.

Oi—4 inches to 0; litter of ponderosa pine needles and twigs.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate very thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, medium, and coarse roots; many very fine interstitial pores; 5 percent rounded gravel; 20 percent clay; neutral (pH 6.8); clear wavy boundary.

2Btb1—4 to 17 inches; dark brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, very firm, sticky and plastic; few medium and coarse roots; common fine and medium tubular pores; many prominent clay films in pores and on faces of peds; 5 percent rounded gravel; 40 percent clay; neutral (pH 7.0); clear wavy boundary.

2Btb2—17 to 30 inches; dark yellowish brown (10YR 4/4) gravelly clay loam, light yellowish brown (10YR 6/4) dry; common fine distinct dark brown (7.5YR 4/4) mottles; moderate very coarse subangular blocky structure; very hard, very firm, sticky and plastic; few coarse roots; common medium tubular pores; many prominent clay films in pores and on faces of peds; 15 percent rounded gravel; 40 percent clay; neutral (pH 7.0); gradual irregular boundary.

2Btb3—30 to 42 inches; dark yellowish brown (10YR 4/4) gravelly clay loam, pale brown (10YR 6/3) dry; common fine distinct dark brown (7.5YR 4/4) mottles; massive; very hard, very firm, sticky and plastic; few coarse roots; few fine tubular pores; many prominent clay films in pores; 15 percent rounded gravel; 40 percent clay; neutral (pH 7.0); gradual irregular boundary.

3C1—42 to 56 inches; dark yellowish brown (10YR 4/4) sandy loam, pale brown (10YR 6/3) dry; common fine distinct dark brown (7.5YR 4/4) mottles; massive; hard, firm, slightly sticky and slightly plastic; few fine tubular pores; 55 percent saprolitic gravel-sized fragments and 25 percent saprolitic cobble-sized fragments; neutral (pH 7.0); gradual irregular boundary.

3C2—56 to 65 inches; yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, sticky and slightly plastic; few medium tubular pores; 55 percent saprolitic gravel-

sized fragments and 25 percent saprolitic cobble-sized fragments; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Depth to mottles is 15 to 30 inches.

The O horizon is 3 to 4 inches thick except in areas that have been disturbed.

The A horizon has value of 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is 15 to 25 percent clay and 0 to 10 percent rounded gravel.

The 2Btb horizon has chroma of 3 or 4 when moist or dry. It is clay loam, clay, or gravelly clay loam and is 35 to 50 percent clay. The horizon is 5 to 25 percent rounded gravel and 0 to 10 percent rounded and subrounded cobbles. Total rock fragment content is 5 to 35 percent.

The 3C horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 when dry, and chroma of 3 or 4 when moist or dry. It is sandy loam or loam and is 10 to 20 percent clay. The horizon is 50 to 80 percent weathered tuff or basalt fragments.

Fluvents

Fluvents consist of very deep, somewhat excessively drained or excessively drained soils on flood plains. These soils formed in recent alluvium. Slopes are 0 to 1 percent. The mean annual precipitation is about 9 inches, and the mean annual air temperature is about 48 degrees F.

Representative pedon of Fluvents, 0 to 1 percent slopes; on a flood plain below the old railroad grade; 1,200 feet east and 700 feet south of the northwest corner of the NW$^1/_4$NE$^1/_4$ of sec. 30, T. 9 S., R. 13 E.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; many very fine and fine roots, many very fine interstitial pores; neutral (pH 7.0); clear smooth boundary.

C1—4 to 26 inches; very dark grayish brown (10YR 3/2) sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

2C2—26 to 35 inches; dark grayish brown (10YR 4/2) very fine sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; many very fine interstitial pores; neutral (pH 7.2); abrupt smooth boundary.

3C3—35 to 60 inches; dark brown (10YR 4/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; many fine interstitial pores; moderately alkaline (pH 7.4).

Depth to bedrock is more than 60 inches. The coarse fragment content is 0 to 10 percent. Organic matter content 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 2 or 3 when moist or dry.

The C horizon has value of 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is stratified sand, very fine sand, and coarse sand with thin layers of loamy material.

Fremkle Series

The Fremkle series consists of shallow, well drained soils on hills. These soils formed in ash. Slopes are 0 to 30 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Fremkle sandy loam in an area of Wanoga-Fremkle-Rock outcrop complex, 0 to 15 percent slopes; 200 feet east and 300 feet south of the northwest corner of sec. 8, T. 14 S., R. 11 E.

Oi—1 inch to 0; litter of ponderosa pine and western juniper needles and twigs.

A1—0 to 3 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 10 percent gravel; neutral (pH 7.2); gradual wavy boundary.

A2—3 to 14 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; many fine and medium vesicular pores; 10 percent gravel; neutral (pH 7.2); abrupt smooth boundary.

2R—14 inches; fractured tuff.

Depth to bedrock is 10 to 20 inches.

The A horizon has hue of 10YR, value of 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 when dry. It is 5 to 15 percent gravel.

Fryrear Series

The Fryrear series consists of moderately deep, well drained soils on hills. These soils formed in ash. Slopes are 0 to 50 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Fryrear stony sandy loam in an area of Henkle-Lava flows-Fryrear complex, 15 to 50

percent slopes; 100 feet south of the Fremont Canyon Road; in the northwest corner of the SW1/4 of sec. 24, T. 14 S., R. 10 E.

Oi—0.5 inch to 0; ponderosa pine litter.
A1—0 to 3 inches; dark brown (10YR 3/3) stony sandy loam, dark brown (10YR 3/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine interstitial pores; 5 percent gravel, 5 percent cobbles, and 20 percent stones; neutral (pH 7.0); gradual wavy boundary.
A2—3 to 18 inches; dark brown (10YR 3/3) very stony sandy loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots and few fine, medium, and coarse roots; many very fine interstitial pores; 5 percent gravel, 10 percent cobbles, and 40 percent stones; neutral (pH 7.0); gradual irregular boundary.
Bw—18 to 27 inches; dark yellowish brown (10YR 3/4) very stony sandy loam, dark yellowish brown (10YR 4/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots and few fine, medium, and coarse roots; common very fine interstitial pores and few fine tubular pores; 5 percent gravel, 10 percent cobbles, and 40 percent stones; neutral (pH 7.0); abrupt irregular boundary.
2R—27 inches; fractured basalt; common distinct clay films on fracture faces; 1- to 2-millimeter-thick weathering rind on basalt fragments.

Depth to bedrock is 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 when moist and 3 or 4 when dry, and chroma of 2 or 3 when moist or dry. It is 5 to 10 percent gravel, 5 to 10 percent cobbles, and 15 to 40 percent stones. Total rock fragment content is 25 to 60 percent.

The Bw horizon has hue of 10YR, value of 3 when moist and 4 when dry, and chroma of 4 when moist or dry. It is 5 to 10 percent gravel, 10 to 30 percent cobbles, and 20 to 40 percent stones. Total rock fragment content is 35 to 60 percent. The horizon is very stony sandy loam or very cobbly sandy loam.

Gap Series

The Gap series consists of deep, well drained soils on mountains. These soils formed in ash over colluvium and residuum. Slopes are 0 to 30 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Gap sandy loam, 0 to 15 percent slopes; on Forest Service Road 1150-750, 0.1 mile from junction with Forest Service Road 1150; in the SW1/4SW1/4 of sec. 18, T. 12 S., R. 10 E.

Oi—4 inches to 0; litter of ponderosa pine needles and twigs.
A1—0 to 4 inches; dark brown (10YR 4/3) sandy loam, yellowish brown (10YR 5/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 5 percent gravel; 18 percent clay; neutral (pH 6.8); clear smooth boundary.
A2—4 to 14 inches; reddish brown (5YR 4/4) sandy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine, medium, and coarse roots; common fine tubular pores; 5 percent gravel; 18 percent clay; neutral (pH 7.0); clear smooth boundary.
2Btb1—14 to 18 inches; reddish brown (5YR 4/4) loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few medium and coarse roots; many very fine tubular pores; few faint clay films in pores; 5 percent gravel and 10 percent soft rock fragments; 22 percent clay; neutral (pH 7.0); clear wavy boundary.
2Btb2—18 to 34 inches; reddish brown (5YR 4/4) clay loam, brown (7.5YR 5/4) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few coarse roots; common fine tubular pores; many distinct clay films in pores and on faces of peds; 10 percent gravel and 20 percent soft rock fragments; 28 percent clay; neutral (pH 7.0); clear wavy boundary.
2Btb3—34 to 47 inches; dark brown (7.5YR 4/4) clay loam, strong brown (7.5YR 5/6) dry; strong medium subangular blocky structure; very hard, very firm, sticky and plastic; few coarse roots; common fine tubular pores; many distinct clay films in pores and on faces of peds; 10 percent gravel and 20 percent soft rock fragments; 30 percent clay; neutral (pH 7.0); clear irregular boundary.
2Cr—47 inches; weathered tuff.

Depth to the paralithic contact is 40 to 60 inches. Depth to the buried argillic horizon is 14 to 20 inches.

The O horizon is 2 to 4 inches thick except in areas that have been disturbed.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 or 4 when moist and 5 when dry, and chroma of 3 or 4 when moist and 4 to 6 when dry. The horizon is 10 to 18 percent clay and 0 to 10 percent gravel.

The 2Btb horizon has hue of 5YR or 7.5YR, value of

4 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist and 3 to 6 when dry. The horizon is loam or clay loam and is 18 to 35 percent clay. It is 5 to 10 percent gravel and 10 to 25 percent soft rock fragments.

Gardone Series

The Gardone series consists of very deep, excessively drained soils on lava plains. These soils formed in ash. Slopes are 0 to 20 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Gardone sand in an area of Stookmoor-Gardone-Rock outcrop, 1 to 15 percent slopes; 200 feet east and 100 feet south of the northwest corner of sec. 14, T. 20 S., R. 1 E.

A—0 to 10 inches; dark grayish brown (10YR 4/2) sand, very dark brown (10YR 2/2) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many medium irregular pores; 5 percent gravel; neutral (pH 6.8); clear wavy boundary.

AC—10 to 21 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; single grain; soft, very friable, nonsticky and nonplastic; common very fine roots; many fine and medium irregular pores; 10 percent gravel; neutral (pH 7.0); clear wavy boundary.

C1—21 to 34 inches; pale brown (10YR 6/3) loamy sand, very dark grayish brown (10YR 3/2) moist; single grain; soft, very friable, nonsticky and nonplastic; few very fine roots; many fine and medium irregular pores; 5 percent gravel; neutral (pH 7.0); clear wavy boundary.

C2—34 to 60 inches; light brownish gray (10YR 6/2) loamy sand, very dark grayish brown (10YR 3/2) moist; single grain; soft, very friable, nonsticky and nonplastic; few very fine roots; many fine and medium irregular pores; 5 percent gravel; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to a buried loamy layer is 40 to 60 inches or more.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. It is 0 to 15 percent gravel.

The AC horizon has chroma of 2 or 3 when moist or dry. It is 0 to 25 percent gravel. It is neutral or mildly alkaline.

The C horizon has value of 4 to 7 when dry and 3 to 7 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is loamy sand, sand, or gravelly loamy sand. It is 0 to 25 percent gravel. It is neutral or mildly alkaline.

Glaze Series

The Glaze series consists of deep, well drained soils on mountains. These soils formed in ash over colluvium and residuum. Slopes are 15 to 50 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Glaze sandy loam in an area of Glaze-Prairie-Rock outcrop complex, 30 to 50 percent slopes; in roadcut above road on south side of draw on Forest Service Road 1150, 0.2 mile from junction with Forest Service Road 1140-820; in the $NE^1/_4SE^1/_4$ of sec. 7, T. 12 S., R. 10 E.

Oi—3 inches to 0; litter of ponderosa pine needles and twigs.

A1—0 to 4 inches; dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 4/4) dry; single grain; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; few fine interstitial pores; 5 percent gravel and 5 percent cobbles; 10 percent clay; neutral (pH 6.8); clear smooth boundary.

A2—4 to 19 inches; dark brown (7.5YR 4/4) cobbly sandy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; many very fine and fine interstitial pores; 15 percent gravel and 15 percent cobbles; 15 percent clay; neutral (pH 7.0); gradual wavy boundary.

2Btb1—19 to 33 inches; dark brown (7.5YR 4/4) very cobbly loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common medium roots; many very fine tubular pores; few faint clay films on faces of peds; 30 percent gravel, 20 percent cobbles, and 5 percent stones; 20 percent clay; neutral (pH 7.2); gradual wavy boundary.

2Btb2—33 to 54 inches; dark brown (7.5YR 4/4) extremely stony loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common coarse roots; few fine tubular pores; common faint clay films in pores and on faces of peds; 30 percent gravel, 25 percent cobbles, and 30 percent stones; 20 percent clay; neutral (pH 7.2); clear irregular boundary.

2Cr—54 inches; weathered tuff.

Depth to the paralithic contact is 40 to 60 inches. Depth to the buried argillic horizon is 14 to 20 inches.

The O horizon is 2 to 4 inches thick except in areas that have been disturbed.

The A horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is sandy loam or cobbly sandy loam and is 10 to 18 percent clay. It is 0 to 15 percent gravel and 0 to 15 percent cobbles. Total rock fragment content is 0 to 30 percent.

The 2Btb horizon has hue of 7.5YR, value of 4 or 5 when moist or dry, and chroma of 4 when moist or dry. It is very cobbly loam, extremely stony loam, or very cobbly clay loam and is 18 to 35 percent clay. The horizon is 15 to 30 percent gravel, 15 to 40 percent cobbles, and 10 to 30 percent stones. Total rock fragment content is 35 to 70 percent.

Gosney Series

The Gosney series consists of shallow, somewhat excessively drained soils on lava plains. These soils formed in ash. Slopes are 0 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 Gosney stony loamy sand in an area of Gosney-Rock outcrop-Deskamp complex, 0 to 15 percent slopes; at the northwest corner of the intersection of U.S. Highway 20 and Gosney Road; in the NW$^1/_4$NE$^1/_4$ of sec. 5, T. 18 S., R. 13 E.

A1—0 to 2 inches; grayish brown (10YR 5/2) stony loamy sand, very dark grayish brown (10YR 3/2) moist; single grain; loose, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 5 percent gravel, 5 percent cobbles, and 10 percent stones; neutral (pH 6.8); abrupt smooth boundary.

A2—2 to 4 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 5 percent gravel; neutral (pH 7.2); clear smooth boundary.

AC—4 to 8 inches; grayish brown (10YR 5/2) loamy sand, dark brown (10YR 3/3) moist; single grain; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; 5 percent gravel; neutral (pH 7.2); clear wavy boundary.

C—8 to 14 inches; pale brown (10YR 6/3) loamy sand, dark brown (10YR 3/3) moist; single grain; slightly hard, friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 5 percent gravel and 5 percent cobbles; mildly alkaline (pH 7.4); abrupt irregular boundary.

2R—14 inches; basalt.

Depth to bedrock is 10 to 20 inches. The content of pumice (0.5 to 2.0 millimeters) is 20 to 60 percent.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry and 1 to 3 when moist. The horizon is 5 to 15 percent gravel, 0 to 10 percent cobbles, and 5 to 20 percent stones. Total rock fragment content is 5 to 45 percent. The horizon is 0.5 to 1.0 percent organic matter.

The C horizon has value of 5 or 6 when dry and 3 or 4 when moist. It is loamy sand or gravelly loamy sand. It is 5 to 25 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 10 to 30 percent. The horizon is neutral or mildly alkaline.

Haynap Series

The Haynap series consists of very deep, somewhat excessively drained soils on moraines. These soils formed in ash and scoria. Slopes are 0 to 70 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Haynap very gravelly loamy coarse sand, 0 to 15 percent slopes; in roadcut 0.2 mile from Forest Service Road 1210; in the SW$^1/_4$NE$^1/_4$ of sec. 24, T. 13 S., R. 8 E.

Oi—2 inches to 0; litter of Douglas fir and white fir needles and twigs.

A1—0 to 3 inches; black (10YR 2/1) very gravelly loamy coarse sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; many very fine roots and few fine roots; many very fine and fine irregular pores; 40 percent gravel; neutral (pH 7.0); clear wavy boundary.

A2—3 to 15 inches; dark brown (10YR 3/3) very gravelly loamy coarse sand, brown (10YR 4/3) dry; single grain; loose, nonsticky and nonplastic; many very fine and fine roots, common medium roots, and few coarse roots; many very fine and fine irregular pores; 40 percent gravel; neutral (pH 7.0); clear wavy boundary.

2C1—15 to 18 inches; black (10YR 2/1) extremely gravelly loamy coarse sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; many fine and medium irregular pores; 70 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

2C2—18 to 20 inches; black (10YR 2/1) and dark yellowish brown (10YR 3/6) extremely gravelly loamy coarse sand, gray (10YR 5/1) and yellowish brown (10YR 5/6) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; many fine and medium irregular pores; 70 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

2C3—20 to 29 inches; black (10YR 2/1) extremely gravelly loamy coarse sand, gray (10YR 5/1) dry;

single grain; loose, nonsticky and nonplastic; few very fine roots; many fine and medium irregular pores; 80 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

3C4—29 to 41 inches; very dark gray (10YR 3/1) loamy fine sand, very dark grayish brown (10YR 3/2) dry; single grain; loose, nonsticky and nonplastic; common fine and medium roots; many very fine irregular pores; 2 percent gravel; neutral (pH 7.2); clear irregular boundary.

3C5—41 to 49 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; single grain; loose, nonsticky and nonplastic; common fine and medium roots; many very fine irregular pores; 2 percent gravel; neutral (pH 7.2); clear irregular boundary.

4C6—49 to 62 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; common fine and medium roots and few coarse roots; many very fine irregular pores; 2 percent gravel; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Rock fragments in the profile are gravel-sized cinders.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist and 2 or 3 when dry. The horizon is 35 to 50 percent gravel. It is slightly acid or neutral.

The 2C horizon has hue of 10YR, value of 2 or 3 when moist and 5 when dry, and chroma of 1 to 6 when moist or dry. The horizon is 60 to 90 percent scoriaceous gravel.

The 3C and 4C horizons have hue of 10YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 to 3 when moist or dry. They are loamy fine sand and sandy loam and are 2 to 10 percent gravel.

Haystack Series

The Haystack series consists of very deep, well drained soils on alluvial fans. These soils formed in colluvium. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Haystack loam in an area of Era-Haystack complex, 0 to 8 percent slopes; 200 feet west and 300 feet north of the southeast corner of the NW$^1/_4$ of sec. 26, T. 13 S., R. 13 E.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine interstitial pores; 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

A2—3 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine interstitial pores; 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

AB—6 to 11 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine and fine interstitial pores and many fine vesicular pores; 10 percent gravel; neutral (pH 7.2); clear smooth boundary.

Bt1—11 to 17 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots and few fine roots; many very fine and fine interstitial pores and many fine vesicular pores; 40 percent gravel; few faint clay films in pores and on faces of peds; neutral (pH 7.2); clear wavy boundary.

Bt2—17 to 26 inches; brown (10YR 5/3) extremely gravelly loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots and few fine roots; many fine interstitial pores; 50 percent gravel and 20 percent cobbles; few faint clay films in pores and on faces of peds; mildly alkaline (pH 7.4); clear smooth boundary.

C—26 to 40 inches; brown (10YR 5/3) extremely gravelly loamy sand, dark brown (10YR 3/3) moist; massive; loose, nonsticky and nonplastic; many very fine interstitial pores; 60 percent gravel and 20 percent cobbles; mildly alkaline (pH 7.4); gradual wavy boundary.

Ck—40 to 60 inches; brown (10YR 5/3) extremely gravelly loamy sand, dark brown (10YR 3/3) moist; massive; loose, nonsticky and nonplastic; many very fine interstitial pores; 60 percent gravel and 20 percent cobbles; 5 percent secondary lime nodules and coatings on gravel; strongly effervescent; moderately alkaline (pH 8.0).

Depth to bedrock is more than 60 inches. Depth to secondary lime is 30 to 44 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 15 to 25 percent clay and is 0 to 15 percent gravel.

The Bt horizon has value of 3 or 4 when moist, and

it has chroma of 3 or 4 when moist or dry. It is very gravelly loam, extremely gravelly loam, or very gravelly clay loam. The horizon is 20 to 30 percent clay. It is 35 to 55 percent gravel and 0 to 20 percent cobbles. Total rock fragment content is 35 to 70 percent. The horizon is neutral or mildly alkaline.

The C and Ck horizons are 40 to 60 percent gravel and 10 to 30 percent cobbles. Total rock fragment content is 60 to 80 percent. The C horizon is loamy sand or sandy loam and is 5 to 15 percent clay. The Ck horizon is loamy sand and is 5 to 10 percent clay. The horizons are mildly alkaline or moderately alkaline throughout. Secondary lime occurs as seams and nodules or as coatings on coarse fragments.

Henkle Series

The Henkle series consists of shallow, somewhat excessively drained soils on hills. These soils formed in ash. Slopes are 0 to 50 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Henkle very cobbly sandy loam in an area of Henkle-Fryrear-Lava flows complex, 0 to 15 percent slopes; on the northeast slope of Henkle Butte; in the $NW^1/_4SE^1/_4$ of sec. 24, T. 14 S., R. 10 E.

Oi—0.5 inch to 0; litter of ponderosa pine and western juniper needles and twigs.

A1—0 to 2 inches; very dark brown (10YR 2/2) very cobbly sandy loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 15 percent gravel, 20 percent cobbles, and 10 percent stones; neutral (pH 7.0); gradual wavy boundary.

A2—2 to 17 inches; dark brown (10YR 3/3) very cobbly sandy loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine, fine, and medium roots; many very fine irregular pores; 15 percent gravel, 20 percent cobbles, and 10 percent stones; neutral (pH 7.0); abrupt irregular boundary.

2R—17 inches; fractured basalt; common distinct clay films on fracture faces; 1- to 2-millimeter-thick weathering rind on basalt fragments.

Depth to bedrock is 10 to 20 inches.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 4 when dry, and chroma of 2 or 3 when moist and 3 when dry. It is 10 to 20 percent gravel, 15 to 25 percent cobbles, and 5 to 15 percent stones. Total rock fragment content is 35 to 50 percent.

Holmzie Series

The Holmzie series consists of moderately deep, well drained soils on hills. These soils formed in ash over residuum. Slopes are 0 to 30 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Holmzie loam in an area of Holmzie-Searles complex, 0 to 15 percent slopes; 300 feet east of Holmes Road on jeep trail; in the $SW^1/_4NW^1/_4$ of sec. 23, T. 14 S., R. 11 E.

A—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine and fine roots and common medium roots; many very fine irregular pores; 10 percent pumice (0.5 to 2.0 millimeters); 2 percent gravel and 10 percent cobbles; 23 percent clay; neutral (pH 7.2); clear wavy boundary.

2Btb—7 to 19 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; strong fine and medium subangular blocky structure; hard, firm, slightly sticky and plastic; few fine and coarse roots and common medium roots; few fine vesicular pores, few medium tubular pores, and common fine irregular pores; 10 percent pumice (0.5 to 2.0 millimeters); 2 percent gravel and 10 percent cobbles; common distinct clay films on peds and in pores; 33 percent clay; neutral (pH 7.2); clear wavy boundary.

3Btb—19 to 29 inches; reddish brown (5YR 4/3) gravelly clay, reddish brown (5YR 4/3) moist; strong fine and medium subangular blocky structure; hard, very firm, slightly sticky and plastic; few fine roots; few fine vesicular pores, few medium tubular pores, and common fine irregular pores; 20 percent gravel and 10 percent cobbles; many prominent clay films on peds and in pores; 45 percent clay; mildly alkaline (pH 7.6); clear wavy boundary.

3Cr—29 inches; weathered tuff.

Depth to the paralithic contact is 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 when dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 5 to 15 percent.

The 2Btb horizon has hue of 10YR, value of 3 when moist and 3 or 4 when dry, and chroma of 3 when moist or dry. It is clay loam or gravelly clay loam and is 30 to 40 percent clay. The horizon is 0 to 15 percent

gravel and 0 to 10 percent cobbles. Total rock fragment content is 5 to 20 percent.

The 3Btb horizon has hue of 7.5YR or 5YR, value of 4 when moist or dry, and chroma of 3 when moist or dry. It is gravelly clay or cobbly clay and is 40 to 50 percent clay. The horizon is 10 to 30 percent gravel and 5 to 15 percent cobbles. Total rock fragment content is 15 to 35 percent.

Houstake Series

The Houstake series consists of very deep, well drained soils on lava plains. These soils formed in ash. Slopes are 0 to 8 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Houstake sandy loam in an area of Deschutes-Houstake complex, 0 to 8 percent slopes; 100 feet east and 200 feet south of the northwest corner of sec. 34, T. 15 S., R. 13 E.

A—0 to 5 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine interstitial pores; 10 percent clay; neutral (pH 7.3); clear smooth boundary.

AB—5 to 17 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine tubular and interstitial pores; 10 percent clay; mildly alkaline (pH 7.4); abrupt wavy boundary.

Bw—17 to 22 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; moderate fine, medium, and coarse angular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots; common fine and medium tubular pores; 15 percent clay; slightly effervescent; mildly alkaline (pH 7.6); clear wavy boundary.

2Bq1—22 to 30 inches; light brownish gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; moderate fine, medium, and coarse angular blocky structure; hard, very firm and brittle, nonsticky and nonplastic; common very fine and fine roots; few medium and coarse tubular pores; 15 percent clay; slightly effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

2Bq2—30 to 60 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; moderate fine, medium, and coarse angular blocky structure; hard, very firm and brittle, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial and tubular pores; 10 percent clay; slightly effervescent; moderately alkaline (pH 8.2).

Depth to bedrock is more than 60 inches. Depth to the brittle layer is 20 to 40 inches.

The A horizon has chroma of 2 or 3.

The Bw horizon is sandy loam or loamy sand. It is neutral or mildly alkaline.

The 2Bq horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is sandy loam or fine sandy loam. It is very gravelly below a depth of 40 inches in some pedons. It is mildly alkaline or moderately alkaline.

Iris Series

The Iris series consists of very deep, well drained soils in lake basins on lava plains. These soils formed in alluvium and loess. Slopes are 0 to 1 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Iris silt loam, 0 to 1 percent slopes; 1.2 miles west of Culver; 700 feet south and 100 feet east of the northwest corner of the SE¼ of sec. 24, T. 12 S., R. 12 E.

Ap—0 to 4 inches; brown (10YR 5/3) silt loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine interstitial pores; neutral (pH 7.2); clear smooth boundary.

A—4 to 14 inches; brown (10YR 5/3) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine interstitial pores; neutral (pH 7.2); clear smooth boundary.

Bw—14 to 34 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; few very fine roots; many very fine tubular pores; mildly alkaline (pH 7.6); clear wavy boundary.

Bkq—34 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; hard, firm and brittle, slightly sticky and nonplastic; many very fine tubular pores; slightly effervescent; mildly alkaline (pH 7.6).

Depth to bedrock is 60 inches or more. Depth to carbonates and to the brittle layer is 20 to 40 inches.

The A horizon hue of 10YR, value of 5 when dry and 3 when moist, and chroma of 2 or 3 when moist or dry.

The Bw horizon has hue of 10YR, value of 6 when dry and 3 when moist, and chroma of 2 or 3 when moist or dry. It is neutral or mildly alkaline.

The Bkq horizon has hue of 10YR, value of 6 when dry and 3 or 4 when moist, and chroma of 2 or 3 when moist or dry.

Kweo Series

The Kweo series consists of excessively drained soils that are moderately deep to cinders. These soils are on cinder cones. They formed in ash over cinders. Slopes are 8 to 50 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Kweo gravelly sandy loam, 8 to 50 percent slopes; on east slope of cinder cone; in the NW$^1/_4$NW$^1/_4$ of sec. 22, T. 12 S., R. 9 E.

Oi—1 inch to 0; mat of ponderosa pine and Douglas fir needles and twigs.

A—0 to 13 inches; dark brown (7.5YR 3/4) gravelly sandy loam, brown (7.5YR 5/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine irregular pores; 20 percent angular gravel and 5 percent angular cobbles; neutral (pH 7.2); gradual wavy boundary.

AC—13 to 25 inches; dark reddish brown (5YR 3/4) very gravelly sandy loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots and few very fine, medium, and coarse roots; common fine irregular and vesicular pores; 40 percent angular gravel and 5 percent angular cobbles; neutral (pH 7.2); clear wavy boundary.

C—25 to 60 inches; dark yellowish brown (10YR 4/6) cinders, yellowish brown (10YR 5/6) dry; single grain; loose, nonsticky and nonplastic; few fine roots; many medium vesicular pores; less than 10 percent of voids filled; neutral (pH 7.2).

Thickness of the solum and depth to cinders are 20 to 35 inches. Depth to bedrock is more than 60 inches.

The A horizon has hue of 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 4 when moist or dry. It is 15 to 25 percent gravel and 0 to 10 percent cobbles. Total coarse fragment content (cinders) is 15 to 30 percent. Content of clay is 5 to 15 percent.

The AC horizon has hue of 5YR or 7.5YR when moist and 7.5YR when dry, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 when moist or dry. It is gravelly or very gravelly sandy loam. The horizon is 25 to 35 percent gravel and 0 to 10 percent cobbles. Total coarse fragment content (cinders) is 25 to 40 percent. The horizon is 5 to 15 percent clay.

The C horizon has hue of 5YR to 10YR, value of 3 or 4 when moist and 3 to 5 when dry, and chroma of 2 to 6 when moist or dry. It is 90 to 100 percent gravel-sized cinders.

Lafollette Series

The Lafollette series consists of well drained soils that are moderately deep to very gravelly old alluvium. These soils are on stream terraces. They formed in ash over old alluvium. Slopes are 0 to 8 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Lafollette sandy loam, 0 to 3 percent slopes; 300 feet east of gravel road off Lower Bridge Road; in the NW$^1/_4$NE$^1/_4$ of sec. 19, T. 14 S., R. 12 E.

A1—0 to 6 inches; brown (10YR 5/3) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 10 percent clay; neutral (pH 6.8); abrupt smooth boundary.

A2—6 to 24 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 10 percent gravel; 10 percent clay; neutral (pH 6.8); clear wavy boundary.

2AC—24 to 35 inches; pale brown (10YR 6/3) very gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine tubular pores; 40 percent rounded gravel; 15 percent clay; neutral (pH 7.0); clear wavy boundary.

2C1—35 to 42 inches; very gravelly sandy loam that has pale brown (10YR 6/3) matrix with multicolored (10YR 6/2, 7/1, and 5/3) sand particles, dark yellowish brown (10YR 4/4) moist; massive; hard, friable, slightly sticky and slightly plastic; 55 percent rounded gravel; 10 percent clay; neutral (pH 7.0); abrupt smooth boundary.

3C2—42 to 60 inches; extremely gravelly loamy coarse sand that has dark gray (10YR 4/1) matrix and multicolored (10YR 6/2, 7/1, and 5/3) sand particles, black (10YR 2/1) moist; 80 percent rounded gravel and 10 percent rounded cobbles; neutral (pH 7.0).

Depth to bedrock is 60 inches or more. Depth to the very gravelly substratum is 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 5 when dry, and chroma of 2 when moist and 3 when dry. It is 0 to 10 percent gravel and 5 to 10 percent clay.

The 2AC horizon has hue of 10YR, value of 4 when moist and 6 when dry, and chroma of 3 when moist and 4 when dry. It is 35 to 60 percent gravel and 5 to 10 percent clay.

The 2C and 3C horizons have hue of 10YR, value of 4 when moist and 6 when dry, and chroma of 3 when moist and 4 when dry. The 2C horizon is 35 to 60 percent gravel and 5 to 10 percent clay, and the 3C horizon is 65 to 80 percent gravel and 0 to 5 percent clay.

A thin layer of welded tuff is between the 2AC and 2C horizons in some pedons.

Laidlaw Series

The Laidlaw series consists of very deep, well drained soils in swales on hills. These soils formed in ash over old alluvium. Slopes are 0 to 15 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Laidlaw sandy loam, 0 to 15 percent slopes; 200 feet south and 200 feet east of the northwest corner of sec. 24, T. 14 S., R. 10 E.

Oi—1 inch to 0; litter of ponderosa pine twigs and needles.

A1—0 to 5 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; weak very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine roots; many very fine interstitial pores; 2 percent gravel; neutral (pH 7.0); clear wavy boundary.

A2—5 to 15 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores; 2 percent gravel; neutral (pH 7.0); gradual wavy boundary.

Bw—15 to 26 inches; dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 4/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 2 percent gravel; neutral (pH 7.0); clear wavy boundary.

Bq1—26 to 38 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots; few medium tubular pores and many fine vesicular pores; 10 percent silica nodules that are hard or very hard when dry, are firm when moist, and have iron and manganese stains; 2 percent gravel; neutral (pH 7.2); clear wavy boundary.

2Bq2—38 to 45 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 4/3) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few fine, medium, and coarse roots; few medium tubular pores and many fine interstitial pores; 30 percent silica nodules that are hard or very hard when dry and are firm when moist; neutral (pH 7.2); gradual wavy boundary.

2Bq3—45 to 60 inches; dark brown (10YR 3/3) loamy fine sand, dark grayish brown (2.5Y 4/2) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few fine, medium, and coarse roots; few medium tubular pores and many fine interstitial pores; 10 percent silica nodules that are hard or very hard when dry and are firm when moist; neutral (pH 7.2).

Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR, value of 3 when moist and 4 when dry, and chroma of 3 when moist and 3 or 4 when dry. It is 0 to 5 percent gravel.

The 2Bq horizon has hue of 10YR or 2.5Y, value of 3 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. It is fine sandy loam or loamy fine sand. It is 0 to 5 percent gravel and 5 to 30 percent silica nodules.

A 2C horizon, where present, has hue of 10YR, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 4 to 6 when moist or dry. It is 25 to 35 percent pumiceous gravel and 60 to 80 percent pumice sand (0.5 to 2.0 millimeters). It is hard and brittle.

Lapine Series

The Lapine series consists of very deep, excessively drained soils on pumice-mantled lava plains and hills. These soils formed in pumice and ash. Slopes are 0 to 70 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Lapine gravelly loamy coarse sand, low, 0 to 3 percent slopes; 800 feet east and 1,200 feet south of the northwest corner of sec. 7, T. 25 S., R. 9 E.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) gravelly loamy coarse sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable,

nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine interstitial pores; 15 percent gravel-sized pumice; slightly acid (pH 6.5); clear smooth boundary.

A2—3 to 7 inches; dark brown (10YR 3/3) gravelly loamy coarse sand, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine interstitial pores; 20 percent gravel-sized pumice; slightly acid (pH 6.5); clear smooth boundary.

C1—7 to 24 inches; very pale brown (10YR 7/4) extremely gravelly loamy coarse sand, white (2.5Y 8/2) and pale yellow (2.5Y 8/4) dry; single grain; loose, nonsticky and nonplastic; common very fine and fine roots and few medium roots; many very fine and fine interstitial pores; 65 percent gravel-sized pumice; neutral (pH 6.6); clear smooth boundary.

C2—24 to 37 inches; light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) very gravelly coarse sand, white (2.5Y 8/2) and pale yellow (2.5Y 8/4) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine and fine interstitial pores; 40 percent gravel-sized pumice; neutral (pH 6.8); clear smooth boundary.

C3—37 to 49 inches; light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) gravelly coarse sand, white (N 8/0) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine interstitial pores; 30 percent gravel-sized pumice; neutral (pH 7.0); clear smooth boundary.

C4—49 to 60 inches; light gray (2.5Y 7/2), pale yellow (2.5Y 7/4), and light brownish gray (2.5Y 6/2) gravelly coarse sand, white (N 8/0) dry; single grain; loose, nonsticky and nonplastic; 20 percent gravel-sized pumice; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to buried loamy material is 40 to 60 inches or more. The particle-size control section averages 35 to 70 percent gravel-sized pumice fragments.

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 15 to 35 percent gravel-sized pumice fragments.

The C horizon has hue of 10YR to 2.5Y, value of 5 to 7 when moist and 6 to 8 when dry, and chroma of 0 to 4 when moist or dry. It is loamy coarse sand or coarse sand and is 40 to 70 percent gravel-sized pumice fragments. It is slightly acid or neutral.

Lickskillet Series

The Lickskillet series consists of shallow, well drained soils on hills and canyonsides. These soils formed in colluvium. Slopes are 0 to 80 percent. The mean annual precipitation is about 9 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Lickskillet very gravelly loam in an area of Lickskillet-Redcliff very gravelly loams, 30 to 60 percent south slopes; 200 feet south and 300 feet east of the northwest corner of the NE$^1/_4$ of sec. 24, T. 13 S., R. 13 E.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 45 percent gravel; neutral (pH 7.2); clear wavy boundary.

A2—4 to 9 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark brown (10YR 2/2) moist; weak very fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 45 percent gravel; neutral (pH 7.2); clear wavy boundary.

Bw—9 to 13 inches; brown (10YR 5/3) extremely gravelly loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; 70 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

R—13 inches; fractured rhyolite.

Depth to bedrock is 12 to 20 inches.

The A horizon has value of 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is very stony sandy loam or very gravelly loam.

The Bw horizon has value of 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry. It is very gravelly loam, extremely gravelly loam, very cobbly loam, or very cobbly sandy loam. The horizon is 50 to 75 percent rock fragments. It is neutral or mildly alkaline.

Some of the Lickskillet soils in this survey area have a sandy loam subsoil (less than 18 percent clay), which is outside the range of characteristics for the

series. These soils are between Bend and Juniper Butte.

Linksterly Series

The Linksterly series consists of very deep, well drained soils on moraines. These soils formed in ash over glacial till. Slopes are 0 to 50 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Linksterly sandy loam, 15 to 30 percent slopes; in the NW¼NE¼ of sec. 21, T. 13 S., R. 8 E.

Oi—3 inches to 0; litter of white fir and Douglas fir needles and twigs.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; 2 percent gravel; neutral (pH 7.0); gradual wavy boundary.

A2—4 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine and medium roots; many very fine irregular pores; 2 percent gravel; neutral (pH 7.0); gradual wavy boundary.

2C1—14 to 32 inches; black (10YR 2/1) loamy fine sand, dark grayish brown (10YR 4/2) dry; single grain; loose, very friable, nonsticky and nonplastic; few coarse roots and common fine and medium roots; many very fine irregular pores; 2 percent gravel; neutral (pH 7.0); clear wavy boundary.

2C2—32 to 41 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots and common medium and coarse roots; many very fine irregular pores and few fine tubular pores; 5 percent gravel; neutral (pH 7.0); clear irregular boundary.

3C3—41 to 60 inches; dark reddish brown (7.5YR 3/4) very cobbly sandy loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weak fine, medium, and coarse roots; many very fine irregular pores and few fine tubular pores; 20 percent gravel, 20 percent cobbles, and 10 percent stones; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to glacial till is 40 to 60 inches.

The O horizon is 1 to 4 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR, value of 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is 5 to 15 percent clay and 2 to 5 percent gravel.

The 2C horizon has hue of 10YR, value of 2 or 3 when moist and 4 when dry, and chroma of 1 or 2 when moist and 2 to 4 when dry. It is 5 to 10 percent clay and 2 to 5 percent gravel.

The 3C horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 when dry, and chroma of 4 when moist and 4 or 6 when dry. The horizon is very cobbly sandy loam or very cobbly loam. It is 15 to 25 percent gravel, 15 to 25 percent cobbles, and 5 to 15 percent stones. Total rock fragment content is 35 to 50 percent. The horizon is 10 to 18 percent clay.

Lundgren Series

The Lundgren series consists of well drained soils that are moderately deep to glacial outwash. These soils are on outwash plains. They formed in ash over glacial outwash. Slopes are 0 to 3 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Lundgren sandy loam, 0 to 3 percent slopes; 1,800 feet east and 1,000 feet south of the northwest corner of sec. 36, T. 15 S., R. 10 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; neutral (pH 6.8); clear smooth boundary.

A2—5 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine irregular pores; 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bw—14 to 23 inches; dark brown (10YR 3/3) gravelly sandy loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine irregular pores; 20 percent gravel; neutral (pH 7.0); abrupt wavy boundary.

2C1—23 to 38 inches; dark brown (10YR 4/3) very gravelly loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; few

very fine and fine roots; few very fine and fine irregular pores; 45 percent gravel and 5 percent cobbles; neutral (pH 7.2); gradual wavy boundary.

2C2—38 to 60 inches; brown (10YR 4/3) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 50 percent gravel and 15 percent cobbles; neutral (pH 7.2).

Depth to the glacial outwash material (2C horizon) is 20 to 40 inches. Depth to bedrock is more than 60 inches. The solum is 20 to 60 percent pumice sand (0.5 to 2.0 millimeters).

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 0 to 10 percent gravel.

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. It is 20 to 30 percent gravel.

The 2C 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 gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam and is 35 to 60 percent gravel and 5 to 15 percent cobbles. Total rock fragment content is 40 to 65 percent.

Madras Series

The Madras series consists of moderately deep, well drained soils on lava plains and hills. These soils formed in loess over volcaniclastic sediment of the Deschutes Formation. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Madras loam, 0 to 3 percent slopes; 100 feet east and 50 feet south of the northwest corner of the SW$^1/_4$SW$^1/_4$ of sec. 23, T. 10 S., R. 13 E.

Ap1—0 to 4 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; neutral (pH 6.8); abrupt smooth boundary.

Ap2—4 to 10 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate thick platy structure; hard, friable, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores; neutral (pH 6.8); abrupt smooth boundary.

Bt1—10 to 16 inches; yellowish brown (10YR 5/4) loam, dark brown (10YR 4/3) moist; weak coarse subangular blocky structure; hard, friable, nonsticky and nonplastic; many very fine roots; many very fine tubular pores; few faint clay films lining pores and on faces of peds; 25 percent clay; neutral (pH 7.2); clear smooth boundary.

Bt2—16 to 23 inches; yellowish brown (10YR 5/4) clay loam, dark brown (10YR 4/3) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; common prominent clay films lining pores and on faces of peds; 35 percent clay; mildly alkaline (pH 7.6); clear wavy boundary.

2Crk—23 to 27 inches; consolidated gravel, cobbles, and sand of the Deschutes Formation; moderately effervescent, carbonates along fractures; clear wavy boundary.

2R—27 inches; basalt of the Deschutes Formation.

Depth to bedrock, consisting of basalt or tuff, is 22 to 40 inches. The particle-size control section averages 25 to 35 percent clay.

The A horizon has hue of 10YR, value of 5 when dry and 3 when moist, and chroma of 3 when dry and 2 or 3 when moist. It is sandy loam or loam. It is neutral or mildly alkaline.

The Bt horizon has hue of 10YR, value of 5 when dry and 3 when moist, and chroma of 4 when moist or dry. It is loam, clay loam, cobbly loam, or cobbly clay loam. The horizon is 0 to 20 percent gravel and 0 to 25 percent cobbles. Total rock fragment content is 5 to 30 percent. The horizon is neutral to moderately alkaline.

Menbo Series

The Menbo series consists of moderately deep, well drained soils on hills. These soils formed in colluvium with ash in the upper part. Slopes are 5 to 25 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Menbo stony loam, 5 to 25 percent slopes; on a northeast slope of Pine Mountain; in the SW$^1/_4$NW$^1/_4$ of sec. 20, T. 20 S., R. 16 E.

A1—0 to 3 inches; grayish brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; about 10 percent stones and 10 percent gravel; neutral; clear wavy boundary.

A2—3 to 8 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; about 5

percent cobbles and 20 percent gravel; neutral; clear wavy boundary.
2Bt—8 to 26 inches; brown (10YR 5/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate medium angular blocky structure; hard, firm, very sticky and plastic; common very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and few thin clay films in pores; about 20 percent cobbles and 20 percent gravel; neutral; abrupt irregular boundary.
2R—26 inches; fractured basalt.

Depth to bedrock is 20 to 40 inches. The mollic epipedon is 20 to 35 inches thick.

The A horizon has value of 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is 5 to 15 percent volcanic ash. It is 0 to 25 percent cobbles and stones and 0 to 30 percent gravel.

The 2Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is 35 to 50 percent clay, 15 to 30 percent cobbles and stones, and 20 to 40 percent gravel. It is very gravelly clay loam or very cobbly clay.

Milcan Series

The Milcan series consists of somewhat excessively drained soils that are moderately deep to a duripan. These soils are in basins on lava plains. They formed in ash over old alluvium. Slopes are 0 to 5 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Milcan gravelly sandy loam, 0 to 5 percent slopes; in the NE$^1/_4$NE$^1/_4$SW$^1/_4$ of sec. 34, T. 20 S., R. 16 E.

A1—0 to 8 inches; grayish brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many fine and medium irregular pores; about 25 percent gravel; about 45 percent ash; neutral (pH 7.3); clear smooth boundary.
A2—8 to 17 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many fine and medium irregular pores; about 5 percent gravel; 30 percent ash; mildly alkaline (pH 7.5); gradual smooth boundary.
AB—17 to 24 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 3/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many fine irregular pores; about 5 percent gravel; about 35 percent ash; mildly alkaline (pH 7.4); clear smooth boundary.
Bq—24 to 38 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many very fine irregular pores; about 10 percent gravel; many durinodes and pockets of firm, brittle material; about 15 percent ash; mildly alkaline (pH 7.4); abrupt wavy boundary.
2Bkqm—38 to 60 inches; pale brown (10YR 6/3) duripan, dark brown (10YR 3/3) moist; platy; indurated; slightly effervescent.

Depth to the indurated duripan is 20 to 40 inches. Depth to bedrock is more than 60 inches.

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

The lower part of A horizon and the AB horizon have value of 5 to 7 when dry and 3 or 4 when moist, and they have chroma of 2 or 3 when moist or dry. They are loamy sand, gravelly sandy loam, or sandy loam and are 0 to 25 percent gravel. They are neutral or mildly alkaline.

The Bq horizon is sandy loam or gravelly sandy loam. It is 0 to 25 percent gravel. It is neutral to moderately alkaline.

Minkwell Series

The Minkwell series consists of very deep, well drained soils on moraines. These soils formed in ash over glacial till. Slopes are 0 to 50 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Minkwell sandy loam, 15 to 30 percent slopes; on Forest Service Road 1280-220, 0.5 mile from junction with Forest Service Road 1280-200; in the NE$^1/_4$ of sec. 8, T. 12 S., R. 9 E.

Oi—1 inch to 0; litter of Douglas fir, white fir, and ponderosa pine needles and twigs and incense cedar leaves and twigs.
A1—0 to 2 inches; dark brown (7.5YR 3/4) sandy loam, brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and coarse roots and many medium roots; many very fine and fine interstitial pores; 5 percent subangular gravel (2 to 5 millimeters); neutral (pH 7.0); clear smooth boundary.
A2—2 to 10 inches; dark brown (7.5YR 3/4) sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine granular structure; slightly hard, friable,

nonsticky and nonplastic; common very fine, fine, and coarse roots and many medium roots; many very fine and fine interstitial pores; 5 percent subangular gravel (2 to 5 millimeters); neutral (pH 7.0); gradual wavy boundary.

Bw—10 to 23 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 4/4) dry; weak fine subangular blocky structure parting to single grain; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots and few coarse roots; common very fine and fine interstitial pores; 5 percent subangular gravel (2 to 5 millimeters); 5 percent dark brown, weakly cemented nodules; neutral (pH 7.0); clear irregular boundary.

2Bwb—23 to 34 inches; dark reddish brown (5YR 3/4) cobbly loam, brown (7.5YR 4/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine and medium roots and few coarse roots; common fine interstitial and vesicular pores and few fine tubular pores; 5 percent subangular gravel and 15 percent subangular cobbles; neutral (pH 7.2); gradual wavy boundary.

3Btb1—34 to 47 inches; dark reddish brown (5YR 3/4) cobbly clay loam, brown (7.5YR 4/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots and few coarse roots; common fine interstitial and vesicular pores and few fine tubular pores; common distinct clay films on peds and in pores; 5 percent subangular gravel and 15 percent subangular cobbles; neutral (pH 7.2); gradual wavy boundary.

3Btb2—47 to 60 inches; dark brown (7.5YR 3/4) cobbly clay loam, brown (7.5YR 4/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine, medium, and coarse roots; common fine interstitial and vesicular pores and few fine tubular pores; many distinct clay films on peds and in pores; 5 percent gravel and 10 percent cobbles; neutral (pH 7.2).

Depth to cobbly glacial till material (2Bwb horizon) is 20 to 30 inches. Depth to the buried argillic horizon (3Btb horizon) is 30 to 40 inches. Depth to bedrock is more than 60 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 7.5YR when moist and 7.5YR or 10YR when dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 4 when moist and 3 or 4 when dry. The horizon is 5 to 15 percent clay. It is 0 to 10 percent subangular gravel and 0 to 5 percent cobbles. Total rock fragment content is 0 to 15 percent.

The 2Bwb horizon has hue of 5YR when moist and 7.5YR when dry, value of 3 when moist and 4 when dry, and chroma of 4 when moist or dry. The horizon is 15 to 27 percent clay. It is 0 to 10 percent subangular gravel, 10 to 20 percent subangular cobbles, and 0 to 5 percent subangular stones. Total rock fragment content is 15 to 35 percent.

The 3Btb horizon has hue of 5YR and 7.5YR when moist or dry, value of 3 when moist and 4 when dry, and chroma of 4 when moist or dry. It is cobbly loam or cobbly clay loam and is 20 to 35 percent clay. The horizon is 5 to 10 percent subangular gravel, 10 to 20 percent subangular cobbles, and 0 to 50 percent subangular stones. Total rock fragment content is 15 to 35 percent.

Ninemile Series

The Ninemile series consists of shallow, well drained soils on lava plains. These soils formed in residuum derived from basalt with ash in the upper part. Slopes are 0 to 10 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Ninemile sandy loam, 0 to 10 percent slopes; 400 feet north and 1,600 feet east of the southwest corner of sec. 34, T. 22 S., R. 20 E.

A1—0 to 2 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine vesicular pores; 5 percent gravel, 5 percent cobbles, and 2 percent stones; neutral (pH 7.2); abrupt wavy boundary.

A2—2 to 7 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate thick platy structure; soft, very friable, nonsticky and nonplastic; common fine roots and few medium roots; many fine and medium vesicular pores; 5 percent gravel and 5 percent cobbles; mildly alkaline (pH 7.6); abrupt wavy boundary.

2Bt1—7 to 12 inches; pale brown (10YR 6/3) clay, brown (10YR 4/3) moist; strong fine angular blocky structure; very hard, very firm, sticky and plastic; many fine roots; many very fine and common fine tubular pores; few faint clay films on faces of peds and in pores; 5 percent gravel and 5 percent cobbles; mildly alkaline (pH 7.8); clear wavy boundary.

2Bt2—12 to 19 inches; yellowish brown (10YR 5/4)

gravelly clay, dark yellowish brown (7.5YR 4/4) moist; strong fine angular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common faint clay films on faces of peds and in pores; 15 percent gravel and 5 percent cobbles; moderately alkaline (pH 8.4); abrupt irregular boundary.

2R—19 inches; fractured basalt; thin, discontinuous coating of opal on surface and in fractures.

Depth to bedrock is 10 to 20 inches. The mollic epipedon is 7 to 12 inches thick.

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 sandy loam or very cobbly loam. It is 2 to 7 inches thick.

The 2Bt horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when dry. The horizon is gravelly clay or clay.

Omahaling Series

The Omahaling series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in ash over older alluvium. Slopes are 0 to 5 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Omahaling fine sandy loam, 0 to 5 percent slopes; 400 feet south and 100 feet west of the northeast corner of the SW$^1/_4$ of sec. 26, T. 14 S., R. 10 E.

Ap—0 to 4 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; mildly alkaline (pH 7.4); abrupt wavy boundary.

AC—4 to 19 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; many very fine irregular pores; 5 percent rounded gravel; mildly alkaline (pH 7.4); abrupt wavy boundary.

2C1—19 to 23 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine distinct dark yellowish brown mottles; weak thin platy structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine tubular pores; mildly alkaline (pH 7.6); abrupt wavy boundary.

2C2—23 to 29 inches; very dark brown (10YR 2/2) gravelly sand, dark gray (10YR 4/1) dry; common medium distinct dark yellowish brown mottles; single grain; loose, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 20 percent subrounded gravel; 5 percent iron-cemented lenses 1 to 2 centimeters thick; mildly alkaline (pH 7.6); abrupt wavy boundary.

2C3—29 to 48 inches; very dark brown (10YR 2/2) silt loam with lenses of very fine sandy loam throughout, dark grayish brown (10YR 4/2) dry; common fine distinct dark yellowish brown mottles generally adjacent to roots and lining pores; massive; slightly hard, friable, sticky and nonplastic; few medium roots; few fine irregular pores; mildly alkaline (pH 7.6); abrupt wavy boundary.

3C4—48 to 60 inches; very dark brown (10YR 2/2) extremely gravelly coarse sand, dark gray (10YR 4/1) dry; massive; loose, nonsticky and nonplastic; 80 percent rounded gravel and 5 percent rounded cobbles; mildly alkaline (pH 7.8).

Depth to bedrock is 60 inches or more. Depth to mottles that have chroma of 2 or less is 15 to 30 inches.

The A horizon has hue of 10YR, value of 2 when moist and 4 or 5 when dry, and chroma of 2 when moist or dry. It is 0 to 10 percent rounded gravel. It is neutral or mildly alkaline.

The 2C horizon has hue of 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 when moist and 1 or 2 when dry. It is 0 to 25 percent gravel. It has common distinct or prominent mottles. The horizon is silt loam, very fine sandy loam, or loam and has strata of sand. It is neutral or mildly alkaline.

The 3C horizon has hue of 10YR, value of 2 or 3 when moist and 4 when dry, and chroma of 2 or 3 when moist and 1 or 2 when dry. It is 60 to 80 percent gravel and 5 to 15 percent cobbles. Total coarse fragment content is 65 to 95 percent.

Parrego Series

The Parrego series consists of moderately deep, well drained soils on mountains. These soils formed in ash over colluvium and residuum. Slopes are 0 to 50 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Parrego sandy loam in an area of Windego-Parrego complex, 0 to 15 percent slopes; on Forest Service Road 1193-130, 0.2 mile east of junction with Forest Service Road 1193; in the NW$^1/_4$NW$^1/_4$ of sec. 35, T. 12 S., R. 10 E.

Oi—3 inches to 0; litter of conifer needles and twigs.
A1—0 to 5 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak medium granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots and few coarse roots; many fine interstitial pores; 25 percent soft rock fragments; 10 percent clay; neutral (pH 6.8); clear wavy boundary.
2A2—5 to 13 inches; brown (7.5YR 4/4) loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine, medium, and coarse roots; many very fine interstitial pores; 25 percent soft rock fragments; 20 percent clay; neutral (pH 7.0); clear wavy boundary.
2Btb—13 to 24 inches; brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common medium and coarse roots; many fine and very fine tubular pores; common distinct clay films on faces of peds and in pores; 50 percent soft rock fragments; 30 percent clay; neutral (pH 7.0); clear wavy boundary.
2Cr—24 inches; weathered tuff.

Depth to the paralithic contact is 20 to 40 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 3 when moist or dry. It is 5 to 18 percent clay. Total soft rock fragment content is 15 to 30 percent. The horizon is slightly acid or neutral. It is 4 to 7 inches thick.

The 2A2 horizon has chroma of 3 or 4 when moist or dry. It is 10 to 25 percent clay. Total soft rock fragment content is 15 to 30 percent.

The 2Btb horizon has chroma of 3 to 5 when dry. The horizon is clay loam or loam and is 20 to 35 percent clay. Total soft rock fragment content is 35 to 60 percent.

Plainview Series

The Plainview series consists of well drained soils that are moderately deep to glacial outwash. These soils are on outwash plains. They formed in ash over glacial outwash. Slopes are 0 to 8 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Plainview sandy loam, 0 to 3 percent slopes; 2,000 feet east and 500 feet south of the northwest corner of sec. 6, T. 16 S., R. 11 E.

A1—0 to 11 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; neutral (pH 6.8); clear smooth boundary.
A2—11 to 16 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine vesicular pores; 5 percent gravel; neutral (pH 7.0); gradual smooth boundary.
Bw1—16 to 23 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine vesicular pores; 10 percent gravel; neutral (pH 7.2); clear smooth boundary.
2Bw2—23 to 27 inches; pale brown (10YR 6/3) very gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine vesicular pores; 35 percent gravel; neutral (pH 7.2); gradual smooth boundary.
2Bw3—27 to 33 inches; light brownish gray (10YR 6/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and few fine roots; common very fine and fine vesicular pores; 55 percent gravel; mildly alkaline (pH 7.6); clear smooth boundary.
3C1—33 to 39 inches; pale brown (10YR 6/3) extremely gravelly sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine irregular pores; 65 percent gravel and 10 percent cobbles; mildly alkaline (pH 7.6); clear smooth boundary.
3C2—39 to 55 inches; light brownish gray (10YR 6/2) very gravelly loamy sand, very dark grayish brown (10YR 3/2) and dark yellowish brown (10YR 4/4) moist; single grain; loose, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine irregular pores; 50 percent gravel and 5 percent cobbles; mildly alkaline (pH 7.8); abrupt wavy boundary.
3Ckqm—55 to 60 inches; very dark grayish brown (10YR 3/2) and light gray (10YR 7/2) indurated duripan with 1-millimeter-thick silica lamellae and filaments of carbonates; strongly effervescent; massive; very hard.

Depth to the glacial outwash deposits (2Bw horizon)

is 20 to 40 inches. Depth to bedrock is more than 60 inches. Depth to the strongly cemented or indurated duripan is 50 inches or more. The mantle of ash is 20 to 60 percent pumice sand (0.5 to 2.0 millimeters).

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 to 3 when moist or dry. The horizon is 0 to 10 percent gravel.

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

The 2Bw horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is 30 to 60 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 35 to 60 percent. The horizon is neutral or mildly alkaline.

The 3C horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is extremely gravelly sandy loam or very gravelly loamy sand and is 35 to 50 percent gravel and 5 to 15 percent cobbles. Total rock fragment content is 45 to 65 percent.

Prairie Series

The Prairie series consists of moderately deep, well drained soils on mountains. These soils formed in ash over colluvium and residuum. Slopes are 0 to 50 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Prairie sandy loam in an area of Prairie-Gap complex, 0 to 15 percent slopes; on Forest Service Road 1140-680, 0.4 mile from junction with Forest Service Road 1140-610; in the SW¼SE¼ of sec. 13, T. 12 S., R. 9 E.

Oi—3 inches to 0; litter of ponderosa pine, Douglas fir, and white fir needles and twigs.

A1—0 to 7 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; weak medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; 5 percent gravel; neutral (pH 6.8); gradual smooth boundary.

A2—7 to 16 inches; dark yellowish brown (10YR 3/4) sandy loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine, medium, and coarse roots; many fine irregular pores; 5 percent gravel; neutral (pH 7.0); gradual smooth boundary.

2Btb1—16 to 22 inches; dark brown (10YR 3/3) gravelly loam, brown (10YR 4/3) dry; strong medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few medium and coarse roots; common very fine tubular pores; few faint clay films in pores and on faces of peds; 15 percent gravel; neutral (pH 7.0); clear wavy boundary.

2Btb2—22 to 37 inches; dark brown (7.5YR 4/2) cobbly loam, brown (7.5YR 5/4) dry; strong medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few coarse roots; few fine irregular pores; many faint clay films in pores and on faces of peds; 20 percent gravel, 5 percent cobbles, and 5 percent stones; neutral (pH 7.2); clear wavy boundary.

2Cr—37 inches; weathered basalt.

Depth to the paralithic contact is 20 to 40 inches. Depth to the buried argillic horizon is 14 to 20 inches.

The O horizon is 2 to 4 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. It is 10 to 18 percent clay and 0 to 10 percent gravel.

The 2Btb horizon has hue of 10YR and 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist and 3 or 4 when dry. The horizon is gravelly loam and cobbly loam and is 18 to 27 percent clay. It is 10 to 20 percent gravel and 5 to 15 percent cobbles and stones. Total rock fragment content is 15 to 35 percent.

Redcliff Series

The Redcliff series consists of moderately deep, well drained soils on hills and canyonsides. These soils formed in colluvium. Slopes are 0 to 65 percent. The mean annual precipitation is about 9 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon for Redcliff very gravelly loam in an area of Lickskillet-Redcliff very gravelly loams, 30 to 60 percent south slopes; 300 feet south and 300 feet east of the northwest corner of the NE¼ of sec. 24, T. 13 S., R. 13 E.

A1—0 to 3 inches; brown (10YR 4/3) very gravelly loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; many very fine interstitial pores; 45 percent gravel; neutral (pH 6.8); clear wavy boundary.

A2—3 to 13 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine interstitial pores; 55

percent gravel; neutral (pH 6.8); clear smooth boundary.
AB—13 to 19 inches; brown (10YR 4/3) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine tubular pores; 55 percent gravel; neutral (pH 6.8); gradual smooth boundary.
Bw—19 to 25 inches; dark yellowish brown (10YR 4/4) extremely gravelly clay loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 75 percent gravel; neutral (pH 6.8); clear smooth boundary.
R—25 inches; rhyolite.

Depth to bedrock is 20 to 40 inches. The particle-size control section averages more than 18 percent clay.

The A horizon has chroma of 2 or 3 when moist or dry. It is 15 to 60 percent rock fragments. The horizon is cobbly sandy loam or very gravelly loam.

The Bw horizon has value of 4 or 5 when dry and chroma of 3 or 4 when moist or dry. It is 35 to 85 percent rock fragments. The horizon is extremely gravelly loam, extremely gravelly clay loam, very cobbly sandy loam, extremely cobbly sandy loam, very cobbly loam, or extremely cobbly loam and is 10 to 30 percent clay. It is neutral or mildly alkaline.

Redmond Series

The Redmond series consists of moderately deep, well drained soils on lava plains. These soils formed in ash. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Redmond sandy loam, 0 to 3 percent slopes; in the SW$^1/_4$SW$^1/_4$SE$^1/_4$ of sec. 11, T. 15 S., R. 13 E.

A—0 to 12 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; loose, very friable, nonsticky and nonplastic; common very fine roots and few fine roots; many fine interstitial pores; 10 percent gravel and 5 percent cobbles; neutral (pH 7.0); clear smooth boundary.
2Bwb—12 to 17 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; common very fine tubular pores; 5 percent subangular gravel and 5 percent subangular cobbles; mildly alkaline (pH 7.4); clear wavy boundary.
2Bqb—17 to 21 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; moderate coarse subangular blocky structure; hard, very firm, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; few pendants of calcium carbonate and opal on underside of gravel; 5 percent subangular gravel and 5 percent subangular cobbles; mildly alkaline (pH 7.8); abrupt irregular boundary.
2R—21 inches; basalt.

Depth to bedrock is 20 to 40 inches.

The A horizon has value of 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is sandy loam and is 5 to 15 percent clay. It is 0 to 10 percent gravel and 0 to 5 percent cobbles.

The 2B horizon has value of 5 or 6 when dry and 3 or 4 when moist. It is loam, clay loam, or cobbly loam and is 18 to 30 percent clay. The horizon is 0 to 10 percent gravel and 0 to 10 percent cobbles. It is 0 to 15 percent durinodes. Some rock fragments have coatings of calcium carbonate and opal. The horizon is neutral or mildly alkaline.

Redslide Series

The Redslide series consists of moderately deep, well drained soils on hills and canyonsides. These soils formed in ash and colluvium. Slopes are 15 to 50 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Redslide stony sandy loam in an area of Redslide-Lickskillet complex, 30 to 50 percent north slopes; above O.B. Riley Road; 700 feet north and 800 feet west of the southeast corner of sec. 6, T. 17 S., R. 12 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) stony sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium platy structure; slightly hard, friable, slightly sticky and nonplastic; common medium roots and many very fine and fine roots; many very fine irregular pores; 5 percent gravel, 5 percent cobbles, and 15 percent stones; neutral (pH 7.0); clear smooth boundary.
A2—4 to 21 inches; brown (10YR 5/3) very cobbly sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine, fine, and medium roots; many very fine irregular pores; 20 percent gravel and 30

percent cobbles; neutral (pH 7.2); clear smooth boundary.
Bk—21 to 34 inches; brown (10YR 5/3) extremely cobbly sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common fine, medium, and coarse roots; many very fine irregular pores; 20 percent gravel and 45 percent cobbles; coatings of lime on underside of rock fragments; slightly effervescent; mildly alkaline (pH 7.6); abrupt wavy boundary.
R—34 inches; fractured rhyolite; coatings of lime on bedrock and in fractures.

Depth to bedrock is 20 to 40 inches. The content of pumice sand (0.5 to 2.0 millimeters) is 15 to 30 percent.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is sandy loam or loam and is 5 to 20 percent gravel, 5 to 40 percent cobbles, and 0 to 20 percent stones. Total rock fragment content ranges from 20 to 60 percent.

The Bk horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is sandy loam or loam and is 0 to 20 percent gravel, 40 to 60 percent cobbles, and 0 to 5 percent stones. Total rock fragment content is 50 to 70 percent. The horizon is neutral or mildly alkaline.

Reluctan Series

The Reluctan series consists of moderately deep, well drained soils on lava plains. These soils formed in residuum with ash in the upper part. Slopes are 1 to 20 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Reluctan sandy loam, 1 to 8 percent slopes; in the SE$^1/_4$NW$^1/_4$ of sec. 18, T. 22 S., R. 21 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many fine vesicular pores; 5 percent gravel and 2 percent stones; neutral (pH 7.2) clear wavy boundary.
A2—4 to 10 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; common fine tubular pores; 5 percent gravel and 5 percent cobbles; neutral (pH 7.2); clear wavy boundary.
2Bt1—10 to 21 inches; brown (10YR 5/3) gravelly clay loam, dark brown (10YR 4/3) moist; weak to moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common fine roots and few medium roots; common fine tubular pores; common thin clay films on peds and lining pores; 10 percent gravel and 5 percent cobbles; mildly alkaline (pH 7.4); abrupt wavy boundary.
2Bt2—21 to 25 inches; pale brown (10YR 6/3) gravelly clay loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; hard, very firm, sticky and plastic; few fine and medium roots; few fine tubular pores; 20 percent gravel; few thin clay films on peds and lining pores; mildly alkaline (pH 7.8); abrupt wavy boundary.
2R—25 inches; fractured basalt; thin coating of opal and calcium carbonate in fractures.

Depth to bedrock is 20 to 40 inches.

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

The 2Bt horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is gravelly loam or gravelly clay loam. Rock fragment content is 15 to 35 percent. Clay content is 25 to 35 percent. The horizon is mildly alkaline or moderately alkaline.

Reuter Series

The Reuter series consists of shallow, well drained soils on hills. These soils formed in colluvium over volcaniclastic sediment of the Deschutes Formation. Slopes are 0 to 30 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Reuter sandy loam in an area of Caphealy-Reuter complex, 15 to 30 percent slopes; on the east side of roadcut; 300 feet north and 1,000 feet west of the southeast corner of the NW$^1/_4$ of sec. 36, T. 12 S., R. 12 E.

A1—0 to 3 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine interstitial pores; 5 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.
A2—3 to 12 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; 5 percent

gravel; mildly alkaline (pH 7.6); clear smooth boundary.
2Cr—12 to 24 inches; weathered tuffaceous sandstone; gradual wavy boundary.
2R—24 inches; welded tuff of the Deschutes Formation.

Depth to the paralithic contact is 10 to 20 inches. Depth to hard bedrock is 20 inches or more. The profile is about 10 to 25 percent pumice sand throughout. It is neutral or mildly alkaline throughout.

The A horizon has hue of 10YR, value of 5 when dry and 2 or 3 when moist, and chroma of 2 or 3 when moist or dry. It is 0 to 10 percent rock fragments.

Ruckles Series

The Ruckles series consists of shallow, well drained soils on canyonsides. These soils formed in colluvium. Slopes are 15 to 80 percent. The mean annual precipitation is about 9 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Ruckles extremely cobbly loam in an area of Simas-Ruckles complex, 15 to 40 percent south slopes, along roadcut; 200 feet west and 500 feet north of the southeast corner of the NW1/4 of sec. 11, T. 13 S., R. 11 E.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) extremely cobbly loam, very dark brown (10YR 2/2) moist; weak thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 20 percent clay; 20 percent gravel, 30 percent cobbles, and 15 percent stones; mildly alkaline (pH 7.4); gradual wavy boundary.
A2—3 to 9 inches; dark grayish brown (10YR 4/2) extremely cobbly loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 20 percent clay; 20 percent gravel, 30 percent cobbles, and 15 percent stones; mildly alkaline (pH 7.6); gradual wavy boundary.
Bt1—9 to 14 inches; brown (10YR 4/3) extremely cobbly clay, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine interstitial pores and common very fine tubular pores; few faint clay films in pores and on faces of peds; 40 percent clay; 20 percent gravel, 30 percent cobbles, and 15 percent stones; mildly alkaline (pH 7.6); clear wavy boundary.
Bt2—14 to 18 inches; light yellowish brown (10YR 6/4) cobbly clay, dark grayish brown (10YR 4/2) moist; strong fine and medium subangular blocky structure; very hard, firm, slightly sticky and plastic; few fine, medium, and coarse roots; many fine interstitial pores and common fine tubular pores, many distinct brown (7.5YR 5/3) clay films in pores and on faces of peds; 60 percent clay; 10 percent gravel and 20 percent cobbles; mildly alkaline (pH 7.6); clear smooth boundary.
Cr—18 to 19 inches; weathered tuff; abrupt wavy boundary.
R—19 inches; welded tuff.

Depth to bedrock is 10 to 20 inches. The mollic epipedon is 7 to 12 inches thick. The particle-size control section averages more than 50 percent clay and more than 45 percent rock fragments.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is 20 to 27 percent clay. It is 5 to 40 percent gravel, 20 to 60 percent cobbles, and 0 to 15 percent stones. Total rock fragment content is 60 to 75 percent.

The Bt1 horizon has value of 3 or 4 when moist and chroma of 2 to 4 when moist or dry. It is extremely cobbly clay loam or extremely cobbly clay and is 35 to 50 percent clay. The horizon is 5 to 40 percent gravel, 20 to 60 percent cobbles, and 0 to 15 percent stones. Total rock fragment content is 60 to 75 percent.

The Bt2 horizon has value of 5 or 6 when dry and chroma of 2 to 4 when moist or dry. It is cobbly clay or very cobbly clay and is 45 to 65 percent clay. The horizon is 5 to 25 percent gravel and 15 to 35 percent cobbles. Total rock fragment content is 30 to 60 percent.

Schrier Series

The Schrier series consists of very deep, well drained soils on hills. These soils formed in loess over colluvium. Slopes are 15 to 60 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Schrier silt loam in an area of Schrier-Tub complex, 30 to 60 percent north slopes; 1,500 feet north and 200 feet west of the southeast corner of sec. 36, T. 13 S., R. 13 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many very fine interstitial pores; 10 percent gravel; neutral (pH 6.8); clear wavy boundary.

A2—4 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common fine and medium roots; many very fine interstitial pores; 10 percent gravel; neutral (pH 6.8); abrupt wavy boundary.

2BA—16 to 21 inches; dark brown (10YR 3/3) very gravelly silt loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine, fine, and medium roots; many very fine tubular pores; 40 percent gravel; neutral (pH 7.2); clear wavy boundary.

2Bw—21 to 36 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak medium subangular structure; slightly hard, friable, sticky and nonplastic; few very fine and medium roots; many very fine tubular pores; 10 percent gravel; mildly alkaline (pH 7.4); gradual smooth boundary.

2Bk—36 to 42 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak medium subangular structure; slightly hard, friable, sticky and nonplastic; few fine and medium roots; many very fine tubular pores; 10 percent gravel; strongly effervescent; seams and nodules of secondary carbonates, coatings of carbonates on gravel; moderately alkaline (pH 8.2); clear wavy boundary.

3Ck—42 to 60 inches; dark brown (10YR 4/3) extremely gravelly fine sand, pale brown (10YR 6/3) dry; single grain; loose, very friable, nonsticky and nonplastic; many very fine interstitial pores; 70 percent gravel; seams and nodules of secondary carbonates, coatings of carbonates on gravel; strongly effervescent; moderately alkaline (pH 8.4).

Depth to bedrock is more than 60 inches. Depth to secondary carbonates is 30 to 40 inches. The mollic epipedon is 20 to 30 inches thick.

The A horizon has value of 4 or 5 when dry and chroma of 2 or 3 when moist or dry. It is 0 to 15 percent gravel.

The 2BA horizon has value of 4 or 5 when dry and chroma of 2 or 3 when moist or dry. It is 35 to 45 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 35 to 55 percent.

The 2Bw horizon has value of 5 or 6 when dry and chroma of 2 or 3 when moist or dry. It is 0 to 15 percent gravel. It is loam or silt loam.

The 2Bk horizon has value of 5 or 6 when dry and chroma of 2 or 3 when moist or dry. It is 0 to 15 percent gravel. It has coatings of carbonates on gravel or has seams and nodules of carbonates. The horizon is loam or silt loam.

The 3Ck horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 2 or 3 when moist or dry. It is 65 to 80 percent gravel.

Searles Series

The Searles series consists of moderately deep, well drained soils on lava plains and hills. These soils formed in ash over residuum. Slopes are 0 to 30 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Searles sandy loam in an area of Holmzie-Searles complex, 0 to 15 percent slopes; in the $SW^1/_4NW^1/_4$ of sec. 32, T. 14 S., R. 12 E.

A1—0 to 3 inches; grayish brown (10YR 5/2) sandy loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; loose, very friable, nonsticky and nonplastic; few fine roots; common fine interstitial pores; neutral (pH 7.2); clear smooth boundary.

A2—3 to 7 inches; grayish brown (10YR 5/2) sandy loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; loose, very friable, nonsticky and nonplastic; few fine and medium roots; few fine interstitial pores; 10 percent cobbles; neutral (pH 7.2); clear wavy boundary.

BA—7 to 13 inches; brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; weak medium and coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; few fine, medium, and coarse roots; few fine interstitial pores; 10 percent gravel; neutral (pH 7.2); clear smooth boundary.

2Bt1—13 to 15 inches; brown (10YR 5/3) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few fine roots; common fine interstitial and tubular pores; few faint clay films on peds and in pores; 30 percent gravel and 10 percent cobbles; mildly alkaline (pH 7.4); gradual wavy boundary.

2Bt2—15 to 24 inches; yellowish brown (10YR 5/4) very gravelly clay loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, firm, sticky and plastic; few fine roots; common fine interstitial and tubular pores; 35 percent gravel and 15 percent cobbles; common faint clay films on peds and in pores; mildly alkaline (pH 7.4); clear smooth boundary.

2R—24 inches; basalt; discontinuous coatings of opal and carbonates in fractures.

Depth to bedrock is 20 to 40 inches. The particle-size control section averages more than 50 percent rock fragments.

The A horizon has value of 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is 4 to 7 inches thick.

The BA horizon has chroma of 2 or 3 when moist or dry. It is loam or gravelly loam. It is neutral or mildly alkaline.

The 2Bt horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when dry and 2 to 4 when moist. It is very gravelly loam, very gravelly clay loam, or very cobbly clay loam and is 25 to 35 percent clay. It is 20 to 35 percent gravel and 10 to 30 percent cobbles. Total rock fragment content is 40 to 60 percent. Some pedons have weakly cemented nodules in the lower part of the horizon. The horizon is neutral or mildly alkaline.

Shanahan Series

The Shanahan series consists of very deep, somewhat excessively drained soils on pumice-mantled lava plains and hills. These soils formed in ash over colluvium and old alluvium. Slopes are 0 to 30 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Shanahan loamy coarse sand, 0 to 15 percent slopes; about 200 feet from road to Lapine State Recreation Area; in the NW$^1/_4$NW$^1/_4$ of sec. 11, T. 21 S., R. 10 E.

Oi—1 inch to 0; litter of ponderosa pine needles and twigs.

A1—0 to 3 inches; dark brown (10YR 4/3) loamy coarse sand, brown (10YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 5 percent pumiceous gravel; 50 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8); gradual smooth boundary.

A2—3 to 8 inches; dark yellowish brown (10YR 4/4) loamy coarse sand, brown (10YR 4/3) dry; single grain; soft, very friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; many very fine interstitial pores; 10 percent pumiceous gravel; 50 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8); clear smooth boundary.

AC—8 to 13 inches; yellowish brown (10YR 5/4) gravelly loamy coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; common very fine roots and few fine, medium, and coarse roots; many very fine interstitial pores; 30 percent pumiceous gravel; 70 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8); clear smooth boundary.

C1—13 to 20 inches; yellowish brown (10YR 5/4) and brownish yellow (10YR 6/6) coarse sand, very pale brown (10YR 7/3 and 8/4) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; 5 percent pumiceous gravel; 60 percent pumice (0.5 to 2.0 millimeters); few krotovinas (2.5 centimeters in diameter); neutral (pH 6.8); clear wavy boundary.

C2—20 to 26 inches; brown (10YR 5/3) loamy coarse sand, light yellowish brown (10YR 6/4) dry; single grain; loose, nonsticky and nonplastic; few very fine, fine, and medium roots; many very fine interstitial pores; 5 percent pumiceous gravel; 60 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8); abrupt wavy boundary.

2Bwb1—26 to 37 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 10 percent gravel; 30 percent pumice (0.5 to 2.0 millimeters); common medium distinct iron and manganese mottles; neutral (pH 6.6); gradual wavy boundary.

2Bwb2—37 to 44 inches; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 25 percent gravel; 15 percent pumice (0.5 to 2.0 millimeters); common medium distinct iron and manganese mottles; neutral (pH 6.6); gradual wavy boundary.

3C—44 to 61 inches; very dark gray (10YR 3/1) very gravelly coarse sand, dark gray (10YR 4/1) dry; massive; loose, nonsticky and nonplastic; many very fine interstitial pores; 50 percent gravel; 45 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8).

Depth to the 2Bwb horizon is 20 to 40 inches. Depth to bedrock is more than 60 inches. Depth to the 3C horizon is 40 to 60 inches or more. The profile is slightly acid or neutral.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The upper part of the A horizon has value of 3 or 4 when moist and 4 or 5 when dry, and the lower part has value of 4 to 6 when moist or dry. The horizon has chroma of 2 to 4 when moist or dry. It is 5 to 15 percent pumiceous gravel and 40 to 60 percent pumice (0.5 to 2.0 millimeters).

The AC and C horizons have hue of 10YR or 2.5Y, value of 5 to 8 when moist and 6 to 8 when dry, and chroma of 1 to 8 when moist or dry. They are coarse sand, gravelly coarse sand, or gravelly loamy coarse sand. They are 5 to 30 percent pumiceous gravel and 40 to 70 percent pumice (0.5 to 2.0 millimeters).

The 2Bwb 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. It is sandy loam, loam, or gravelly sandy loam. It is 5 to 30 percent gravel and 10 to 40 percent pumice (0.5 to 2.0 millimeters).

The 3C horizon, where present, is variable material that includes pumice, lake sediment, and localized alluvium. The horizon is 35 to 60 percent gravel. It is very gravelly coarse sand or very gravelly loamy sand.

Shroyton Series

The Shroyton series consists of deep, well drained soils on mountains. These soils formed in ash. Slopes are 30 to 50 percent. The mean annual precipitation is about 40 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Shroyton loamy sand, 30 to 50 percent slopes; in the southwest corner of the SE$^{1}/_{4}$ of sec. 6, T. 17 S., R. 10 E.

Oi—2 inches to 0; ponderosa pine and white fir needles and twigs.

A1—0 to 2 inches; dark brown (7.5YR 3/2) loamy sand, brown (7.5YR 5/4) dry; weak fine granular structure; loose, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine irregular pores; 2 percent gravel; 35 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); gradual wavy boundary.

A2—2 to 15 inches; dark brown (7.5YR 3/2) loamy sand, brown (7.5YR 5/4) dry; weak fine granular structure; loose, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine irregular pores; 2 percent gravel; 35 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); clear irregular boundary.

2Bw1—15 to 31 inches; strong brown (7.5YR 4/6) gravelly coarse sandy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine irregular pores and common fine vesicular pores; 30 percent gravel; 30 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); clear wavy boundary.

3Bw2—31 to 55 inches; dark brown (10YR 3/3) gravelly sandy loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; common very fine and fine irregular pores and common fine vesicular pores; 30 percent gravel; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); abrupt irregular boundary.

4R—55 inches; andesite.

Depth to bedrock is 40 to 60 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 and 3 or 4 when dry. The horizon is 0 to 10 percent gravel and 25 to 40 percent pumice (0.5 to 2.0 millimeters). It is 2 to 6 percent clay.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3, 4, or 6 when moist and 3 or 4 when dry. The horizon is gravelly sandy loam or gravelly coarse sandy loam. It is 15 to 30 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 15 to 35 percent. The horizon is 30 to 60 percent pumice (0.5 to 2.0 millimeters). It is 5 to 10 percent clay.

A gravelly loamy sand or sandy loam C horizon is present in some pedons.

Simas Series

The Simas series consists of very deep, well drained soils on hills and canyonsides. These soils formed in colluvium. Slopes are 0 to 80 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Simas cobbly loam in an area of Simas-Ruckles-Rock outcrop complex, 40 to 80 percent south slopes, along roadcut; 1,000 feet south and 100 feet east of northwest corner of sec. 11, T. 13 S., R. 11 E.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) cobbly loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine interstitial pores; 25 percent cobbles; mildly alkaline (pH 7.4); clear wavy boundary.

A2—3 to 12 inches; dark grayish brown (10YR 4/2) cobbly loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine and fine roots; many very fine interstitial pores; 5 percent gravel and 10 percent cobbles; 30 percent clay; mildly alkaline (pH 7.4); clear wavy boundary.

2Bt1—12 to 19 inches; dark grayish brown (10YR 4/2) cobbly clay, dark brown (10YR 3/3) moist; strong

coarse subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; many fine tubular pores; many faint clay films in pores and on faces of peds; 20 percent cobbles; 55 percent clay; mildly alkaline (pH 7.4); clear wavy boundary.

2Btk2—19 to 28 inches; brown (10YR 4/3) clay, dark yellowish brown (10YR 3/4) moist; strong coarse subangular blocky structure; very hard, very firm, sticky and plastic; few very fine roots; few very fine tubular pores; many prominent clay films in pores and on faces of peds; 60 percent clay; common medium irregular calcareous deposits on faces of peds and in fractures; slightly effervescent; mildly alkaline (pH 7.6); gradual wavy boundary.

2Btk3—28 to 37 inches; brown (10YR 4/3) clay, dark yellowish brown (10YR 3/4) moist; strong medium subangular blocky structure; very hard, very firm, sticky and plastic; few coarse roots; few very fine tubular pores; many prominent clay films in pores and on faces of peds; 60 percent clay; common medium irregular calcareous deposits on faces of peds and in fractures; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Bk—37 to 60 inches; yellowish brown (10YR 5/3) gravelly clay, dark yellowish brown (10YR 3/4) moist; strong medium subangular blocky structure; very hard, very firm, sticky and plastic; many very fine tubular pores; many prominent clay films in pores and on faces of peds; 25 percent gravel and 5 percent cobbles; 50 percent clay; strongly effervescent; moderately alkaline (pH 7.9).

Depth to bedrock is more than 60 inches. Depth to carbonates is 10 to 30 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry. It is silt loam or cobbly loam. The horizon is 0 to 10 percent gravel and 0 to 30 percent cobbles. It is neutral or mildly alkaline.

The 2Bt horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3. It is clay, cobbly clay, or gravelly clay. The horizon is 0 to 25 percent gravel and 0 to 30 percent cobbles. Total rock fragment content is 0 to 35 percent. The horizon is 50 to 60 percent clay. It is neutral or mildly alkaline.

The 2Btk horizon has value of 4 or 5 when dry and chroma of 3 or 4. It has few to many nodules or seams of carbonates. The horizon is mildly alkaline or moderately alkaline and is slightly effervescent or strongly effervescent. Texture and rock fragment content are similar to those of the 2Bt horizon.

The 2Bk horizon is gravelly clay loam, gravelly clay, or cobbly clay. It is 35 to 60 percent clay, 0 to 20 percent cobbles, and 10 to 30 percent gravel. It is moderately alkaline or strongly alkaline.

Sisters Series

The Sisters series consists of very deep, well drained soils on mountains. These soils formed in ash over colluvium and residuum. Slopes are 0 to 50 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Sisters loamy sand in an area of Sisters-Yapoah complex, 0 to 15 percent slopes; 2,000 feet south and 300 feet east of the northwest corner of sec. 14, T. 17 S., R. 10 E.

Oi—2 inches to 0; litter of ponderosa pine needles.

A1—0 to 2 inches; very dark brown (10YR 2/3) loamy sand, dark yellowish brown (10YR 4/4) dry; weak fine granular structure; loose, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 5 percent gravel; 20 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); clear wavy boundary.

A2—2 to 11 inches; dark brown (10YR 3/3) loamy sand, yellowish brown (10YR 5/4) dry; weak fine granular structure; loose, nonsticky and nonplastic; common fine and coarse roots and many medium roots; many very fine interstitial pores; 10 percent gravel; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); gradual wavy boundary.

C—11 to 23 inches; dark yellowish brown (10YR 3/4) loamy sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; common fine, medium, and coarse roots; many very fine interstitial pores; 5 percent gravel; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); gradual wavy boundary.

2Ab—23 to 35 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine interstitial pores; 10 percent gravel; 10 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); clear wavy boundary.

2Bwb1—35 to 47 inches; dark reddish brown (5YR 3/3) clay loam, brown (7.5YR 5/4) dry; weak coarse subangular blocky structure parting to weak thin platy; hard, firm, slightly sticky and slightly plastic; few fine roots; many fine and medium vesicular and tubular pores; 10 percent gravel; 10 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.2); gradual wavy boundary.

2Bwb2—47 to 60 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; weak coarse subangular

blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine roots; many fine, medium, and coarse vesicular and tubular pores; 10 percent gravel; 10 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.2).

Depth to the buried loamy material (2Ab horizon) is 20 to 35 inches. Depth to bedrock is more than 60 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 and 3 or 4 when dry. The horizon is 0 to 10 percent gravel and 20 to 50 percent pumice (0.5 to 2.0 millimeters). It is 2 to 8 percent clay.

The C horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is 0 to 10 percent gravel and 20 to 50 percent pumice (0.5 to 2.0 millimeters). The horizon is 2 to 8 percent clay.

The 2Ab and 2Bwb horizons have hue of 5YR or 7.5YR and chroma of 3 or 4 when moist or dry. They are sandy loam, loam, or clay loam. They are 0 to 15 percent gravel, 18 to 30 percent clay, and 5 to 20 percent pumice (0.5 to 2.0 millimeters).

Smiling Series

The Smiling series consists of very deep, well drained soils on mountains. These soils formed in ash over colluvium. Slopes are 0 to 70 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Smiling sandy loam, 0 to 15 percent slopes, in the SE$^1/_4$SE$^1/_4$NW$^1/_4$ of sec. 2, T. 13 S., R. 9 E.

Oi—1 inch to 0; litter of ponderosa pine needles and grasses.

A1—0 to 4 inches; very dark brown (7.5YR 2/2) sandy loam, dark brown (7.5YR 4/2) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine irregular pores; 10 percent pumice; neutral (pH 7.0); clear smooth boundary.

A2—4 to 16 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 4/2) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; many very fine irregular pores; 10 percent pumice; neutral (pH 7.0); abrupt wavy boundary.

2Btb1—16 to 27 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; weak medium and fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few fine roots and common medium and coarse roots; common very fine tubular pores; few faint clay films on peds and in pores; 5 percent gravel; neutral (pH 7.0); gradual wavy boundary.

2Btb2—27 to 39 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots and common medium and coarse roots; common very fine tubular pores; few faint clay films on peds and in pores; 5 percent gravel; neutral (pH 7.0); clear wavy boundary.

3Btb3—39 to 58 inches; dark brown (7.5YR 3/4) clay loam, brown (7.5YR 5/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few medium roots; common very fine and fine tubular pores; common faint clay films on peds and in pores; 5 percent gravel; neutral (pH 7.0); clear wavy boundary.

3Btb4—58 to 63 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; hard, firm, sticky and slightly plastic; many very fine and fine tubular and interstitial pores; common faint clay films on peds and in pores; 5 percent gravel; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to the buried argillic horizon and thickness of the mantle of ash are 14 to 33 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has value of 2 or 3 when moist and 4 to 6 when dry, and it has chroma of 2 to 4 when moist or dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 0 to 15 percent. The horizon is 5 to 15 percent clay.

A Bw horizon is in the mantle of ash in some pedons.

The 2Btb and 3Btb horizons have value of 3 or 4 when moist and 5 or 6 when dry, and they have chroma of 3 or 4 when moist and 3 to 6 when dry. The horizons are loam, clay loam, gravelly loam, or gravelly clay loam and are 18 to 35 percent clay. They are 5 to 20 percent gravel, 0 to 20 percent cobbles, and 0 to 5 percent stones. Total rock fragment content is 5 to 35 percent.

Statz Series

The Statz series consists of well drained soils that are shallow to a duripan. These soils are on lava plains. They formed in ash. Slopes are 0 to 30 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Statz sandy loam in an area of Statz-Deschutes complex, 0 to 15 percent slopes; about 2,700 feet west and 1,500 feet north of the southeast corner of sec. 3, T. 15 S., R. 12 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 3/2) moist; weak very fine granular structure; loose, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 5 percent gravel; mildly alkaline (pH 7.6); clear smooth boundary.

A2—4 to 14 inches; grayish brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to moderate very fine granular; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine tubular and vesicular pores; 5 percent gravel; moderately alkaline (pH 7.8); abrupt wavy boundary.

2Bkq—14 to 20 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine tubular pores; 5 percent gravel; 10 percent durinodes; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

2Bkqm—20 to 25 inches; indurated duripan; abrupt wavy boundary.

3R—25 inches; basalt.

Depth to bedrock is 20 to 40 inches. Depth to the indurated duripan is 10 to 20 inches.

The A horizon has chroma of 2 or 3 when moist or dry. It is 0 to 15 percent gravel. It is neutral or mildly alkaline.

The 2Bkq has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry. It is sandy loam or loam. The horizon is 0 to 15 percent gravel and 5 to 15 percent durinodes. It is mildly alkaline or moderately alkaline.

Steiger Series

The Steiger series consists of very deep, somewhat excessively drained soils on pumice-mantled lava plains and hills. These soils formed in ash and pumice over colluvium and old alluvium. Slopes are 0 to 50 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Steiger loamy coarse sand, 0 to 15 percent slopes; about 1 mile east of U.S. Highway 97; in the SW$^1/_4$NW$^1/_4$ of sec. 20, T. 23 S., R. 10 E.

Oi—3 inches to 0; ponderosa pine litter.

A—0 to 2 inches; dark grayish brown (10YR 4/2) loamy coarse sand, grayish brown (10YR 5/2) dry; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 10 percent pumiceous gravel; 50 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8); clear irregular boundary.

AC—2 to 18 inches; dark brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; many fine, medium, and coarse roots; many very fine interstitial pores; 25 percent pumiceous gravel; 60 percent pumice (0.5 to 2.0 millimeters); neutral (pH 6.8); clear wavy boundary.

C1—18 to 28 inches; light brownish gray (10YR 6/2) and very pale brown (10YR 8/3) very gravelly coarse sand, very pale brown (10YR 8/3) dry; single grain; loose, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 50 percent pumiceous gravel; 70 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); abrupt wavy boundary.

C2—28 to 49 inches; pale yellow (2.5Y 7/4) and white (2.5Y 8/2) gravelly coarse sand, pale yellow (2.5Y 7/4) and white (2.5Y 8/2) dry; single grain; loose, nonsticky and nonplastic; many fine and medium roots along krotovina; many very fine interstitial pores; common krotovinas (4 inches in diameter); thin subhorizons in lower part; 15 percent pumiceous gravel; 70 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); abrupt smooth boundary.

2Bwb—49 to 60 inches; dark yellowish brown (10YR 3/4) loam, brown (10YR 5/3) dry; common medium brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine roots; many very fine interstitial pores; 5 percent pumiceous gravel, 10 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to the 2Bwb horizon is 40 to 60 inches.

The A horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is 0 to 10 percent pumiceous gravel.

The AC horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is 5 to 35 percent pumiceous gravel. The horizon is coarse sand or loamy coarse sand.

The C horizon has value of 6 to 8 when moist or dry and chroma of 2 to 4 when moist or dry. It has 15 to 60

percent pumiceous gravel. The horizon is coarse sand or loamy coarse sand.

The 2Bwb horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. Some pedons are mottled. The horizon is loam or sandy loam and is 0 to 10 percent pumiceous gravel.

Stookmoor Series

The Stookmoor series consists of moderately deep, somewhat excessively drained soils on hills and lava plains. These soils formed in ash. Slopes are 1 to 50 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Stookmoor loamy sand, 1 to 3 percent slopes; in the NW1/4SW1/4NW1/4 of sec. 11, T. 19 S., R. 15 E.

A—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many fine and medium irregular pores; about 50 percent ash; moderately alkaline; clear wavy boundary.

AB—6 to 14 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many fine irregular pores; about 50 percent ash; moderately alkaline; abrupt wavy boundary.

Bq—14 to 24 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 3/3) moist; massive; very hard, very firm and brittle; slightly sticky and slightly plastic; few very fine roots; common very fine discontinuous tubular pores; about 15 percent ash; moderately alkaline; abrupt wavy boundary.

2R—24 inches; basalt.

Depth to the brittle layer is 14 to 20 inches, and depth to bedrock is 20 to 40 inches. The profile is neutral to moderately alkaline.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. It is loamy sand or gravelly loamy sand and is 0 to 25 percent gravel and 0 to 10 percent cobbles.

The AB horizon has chroma of 2 or 3 when moist or dry. It is loamy sand or sandy loam and is 0 to 25 percent gravel and 0 to 10 percent cobbles.

The 2Bq horizon has value of 6 or 7 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry. It is sandy loam or loam and is 10 to 20 percent clay. It is 0 to 25 percent gravel and 0 to 10 percent cobbles.

Stukel Series

The Stukel series consists of shallow, well drained soils on lava plains. These soils formed in ash. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Stukel sandy loam in an area Deschutes-Stukel complex, dry, 0 to 8 percent slopes; about 0.75 mile north of Oregon Highway 26; in the NE1/4NE1/4 of sec. 14, T. 15 S., R. 13 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak thin and medium platy structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 5 percent cobbles; mildly alkaline (pH 7.4); clear wavy boundary.

A2—4 to 11 inches; brown (10YR 5/3) cobbly sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; many very fine interstitial pores and common very fine tubular pores; 5 percent gravel and 15 percent cobbles; mildly alkaline (pH 7.6); abrupt smooth boundary.

Bkq—11 to 18 inches; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; common very fine tubular pores; 10 percent durinodes; 15 percent gravel and 5 percent cobbles; slightly effervescent with carbonates as filaments and as coatings on rock fragments; mildly alkaline (pH 7.8); abrupt wavy boundary.

R—18 inches; basalt.

Depth to bedrock is 10 to 20 inches. The profile is 5 to 15 percent clay.

The A horizon has value of 4 or 5 when dry and 3 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is 0 to 5 percent gravel and 0 to 15 percent cobbles. It is neutral or mildly alkaline.

The Bkq horizon has value of 5 to 7 when dry and 4 or 5 when moist, and it has chroma of 3 or 4 when moist or dry. The horizon is sandy loam or gravelly sandy loam. It is 5 to 15 percent gravel, 0 to 5 percent cobbles, and 0 to 10 percent durinodes. It is neutral or mildly alkaline.

A thin, weakly cemented horizon is above the bedrock in some pedons.

The R horizon typically is basalt, but in some pedons it consists of other volcanic rock, including tuff.

Suilotem Series

The Suilotem series consists of very deep, somewhat poorly drained soils on outwash plains. These soils formed in ash over glacial outwash. Slopes are 0 to 8 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Suilotem sandy loam in an area of Suilotem-Circle complex, 0 to 8 percent slopes; about 150 feet north of Forest Service Road 1216, northeast of intersection of Forest Service Roads 1216 and 1419; in the NE$^1/_4$ of sec. 9, T. 13 S., R. 9 E.

Oi—1 inch to 0; litter of ponderosa pine and western larch needles and mixed grasses.

A1—0 to 5 inches; dark brown (10YR 3/3) sandy loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; 10 percent pumice (2 to 5 millimeters); neutral (pH 6.6); clear wavy boundary.

A2—5 to 16 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine, medium, and coarse roots; many fine irregular pores; 15 percent pumice (2 to 5 millimeters); neutral (pH 6.8); clear wavy boundary.

C1—16 to 27 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine, medium, and coarse roots; many very fine irregular pores; 10 percent pumice (2 to 5 millimeters); neutral (pH 6.8); clear irregular boundary.

2C2—27 to 30 inches; very dark brown (10YR 2/2) fine sandy loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine, medium, and coarse roots; many very fine irregular pores; 10 percent pumice (2 to 5 millimeters); 5 percent rounded gravel; neutral (pH 7.0); abrupt broken boundary.

2C3—30 to 51 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; common medium and large prominent strong brown (7.5YR 4/6) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few very fine and medium roots; common fine tubular pores; 10 percent rounded gravel; neutral (pH 7.0); abrupt irregular boundary.

3Bwb—51 to 60 inches; dark brown (7.5YR 3/2) very fine sandy loam, pale brown (10YR 6/3) dry; common medium distinct brown (7.5YR 4/4) mottles; strong fine and medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common medium and coarse roots; common fine tubular pores; common medium iron concretions; 5 percent rounded gravel; neutral (pH 7.0).

Depth to glacial outwash material (3Bwb horizon) is 40 to 60 inches. Depth to bedrock is more than 60 inches. Depth to mottles is 30 to 40 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A and C horizons have hue of 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry. They are 5 to 15 percent pumice gravel. They are slightly acid or neutral.

The 2C horizon has hue of 10YR, value of 2 or 3 when moist and 4 to 7 when dry, and chroma of 1 to 3 when moist and 1 to 4 when dry. The horizon is fine sandy loam, loamy fine sand, or sandy loam. It is 5 to 15 percent gravel. It has common or many prominent mottles.

The 3B horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 5 or 6 when dry, and chroma of 2 when moist and 3 or 4 when dry. The horizon is very fine sandy loam or sandy loam. It is 5 to 10 percent gravel and 0 to 5 percent cobbles. Total rock fragment content is 5 to 10 percent. The horizon has common or many distinct or prominent mottles.

Sunriver Series

The Sunriver series consists of very deep, somewhat poorly drained soils on stream terraces. These soils formed in ash over old alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Sunriver sandy loam, 0 to 3 percent slopes; 1,500 feet west and 1,500 feet north of the southeast corner of sec. 1, T. 21 S., R. 10 E.

Oi—2 inches to 0; litter of lodgepole pine needles and twigs.

A—0 to 5 inches; very dark gray (10YR 3/1) sandy loam, light gray (10YR 6/1) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots and common

medium roots; common very fine interstitial pores; 70 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); abrupt wavy boundary.

AC—5 to 20 inches; dark gray (10YR 4/1) loamy coarse sand, light gray (10YR 7/1) dry; single grain; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; 70 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.2); clear smooth boundary.

C1—20 to 24 inches; light brownish gray (10YR 6/2) coarse sand, light gray (10YR 7/2) dry; few fine faint very dark grayish brown (10YR 3/2) mottles; single grain; loose, nonsticky and nonplastic; common very fine interstitial pores; 80 percent pumice (0.5 to 2.0 millimeters); few krotovinas (10 centimeters in diameter); neutral (pH 7.2); abrupt smooth boundary.

C2—24 to 29 inches; light brownish gray (10YR 6/2) coarse sand, very pale brown (10YR 7/3) dry; common medium distinct dark yellowish brown (10YR 3/4), light olive brown (2.5Y 5/6), and dark reddish brown (5YR 3/4) mottles; single grain; loose, nonsticky and nonplastic; common very fine interstitial pores; 80 percent pumice (0.5 to 2.0 millimeters); few krotovinas (10 centimeters in diameter); alternating bands of dark yellowish brown (10YR 3/4) and light brownish gray (10YR 6/2) stains throughout; neutral (pH 7.2); abrupt smooth boundary.

2Bwb—29 to 60 inches; very dark gray (10YR 3/1) sandy loam, pale brown (10YR 6/3) dry; many medium distinct dark reddish brown (5YR 3/4) and dark brown (7.5YR 3/4) mottles; massive; slightly hard, friable, nonsticky and nonplastic; many very fine tubular pores; mildly alkaline (pH 7.4).

Depth to the loamy buried soil is 25 to 35 inches, and depth to bedrock is more than 60 inches. Depth to mottles is 20 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry.

The AC horizon has hue of 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry. The horizon is coarse sand or loamy coarse sand. It is 50 to 80 percent pumice (0.5 to 2.0 millimeters).

The C horizon has hue of 10YR, value of 3 to 7 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist or dry. The horizon is 50 to 80 percent pumice (0.5 to 2.0 millimeters).

The 2B horizon has hue of 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 1 to 4 when moist or dry. The horizon is sandy loam or fine sandy loam. It is neutral or mildly alkaline.

Suttle Series

The Suttle series consists of very deep, somewhat poorly drained soils on outwash plains. These soils formed in ash and scoria over glacial outwash. Slopes are 0 to 15 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Suttle very gravelly loamy sand, 0 to 15 percent slopes; 60 feet north of Forest Service Road 12 and 12 miles up the road; in the $SW^1/_4SW^1/_4$ of sec. 8, T. 13 S., R. 9 E.

Oi—1 inch to 0; Douglas fir needles and twigs and ponderosa pine and white fir needles.

A1—0 to 3 inches; black (10YR 2/1) very gravelly loamy sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; common medium roots and many very fine and fine roots; many very fine interstitial pores; 40 percent angular gravel-sized cinders; slightly acid (pH 6.4); clear smooth boundary.

A2—3 to 10 inches; black (10YR 2/1) very gravelly loamy sand, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores; 35 percent angular gravel-sized cinders; neutral (pH 6.8); abrupt smooth boundary.

2C1—10 to 22 inches; mixed black (10YR 2/1) and dark brown (10YR 3/3) very gravelly coarse sand, dark gray (10YR 4/1) and yellowish brown (10YR 5/4) dry; single grain; loose; nonsticky and nonplastic; few very fine, fine, and medium roots; many very fine interstitial pores; 50 percent angular gravel-sized cinders; neutral (pH 7.0); abrupt smooth boundary.

3C2—22 to 29 inches; dark brown (10YR 3/3) gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine tubular pores; 20 percent subrounded gravel; neutral (pH 7.0); clear irregular boundary.

4C3—29 to 37 inches; black (10YR 2/1) loamy fine sand, very dark grayish brown (10YR 3/2) dry; single grain; soft, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine tubular pores; neutral (pH 7.0); gradual wavy boundary.

5C4—37 to 49 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine tubular pores; neutral (pH 7.0); gradual wavy boundary.

5C5—49 to 60 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine tubular pores; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. Depth to the stratified glacial outwash (3C horizon) is 20 to 30 inches. The profile is slightly acid or neutral.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 10YR when moist or dry, value of 2 or 3 when moist and 4 when dry, and chroma of 1 when moist and 2 to 4 when dry. It is 5 to 15 percent clay and 35 to 50 percent angular gravel-sized cinders.

The 2C horizon has hue of 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist and 1 to 4 when dry. The horizon is 0 to 5 percent clay and 40 to 70 percent angular scoriaceous gravel-sized cinders. It is very gravelly coarse sand or extremely gravelly coarse sand.

The underlying C horizons are stratified gravelly sandy loam, loamy fine sand, and sandy loam. They have hue of 10YR when moist or dry, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 to 3 when moist and 2 to 4 when dry. The horizons are 5 to 15 percent clay and 0 to 30 percent subrounded gravel.

Swaler Series

The Swaler series consists of very deep, moderately well drained soils on old lake terraces. These soils formed in lacustrine sediment. Slopes are 0 to 2 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Swaler silt loam, 0 to 2 percent slopes; 40 feet south of trail; in the $SE^1/_4SE^1/_4NW^1/_4$ of sec. 24, T. 22 S., R. 20 E.

A1—0 to 3 inches; light gray (10YR 7/2) and light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many fine and medium vesicular pores; neutral (pH 6.6); abrupt smooth boundary.

A2—3 to 7 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak thin platy structure parting to weak very fine granular; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; many very fine irregular pores; neutral (pH 6.6); abrupt wavy boundary.

2A3—7 to 10 inches; light gray (10YR 7/1) silt loam, gray (10YR 5/1) moist; weak thin platy structure; hard, friable, slightly sticky and nonplastic; few very fine roots; common very fine tubular pores; neutral (pH 6.8); abrupt wavy boundary.

3Bt1—10 to 14 inches; brown (10YR 5/3) and light gray (10YR 7/1) clay, brown (10YR 3/3) moist; moderate medium and fine prismatic structure parting to moderate fine angular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine tubular pores; common distinct clay films on peds and few faint clay films in pores; about 40 percent light gray uncoated sand and silt grains on peds; few tongues of 2A horizon material; mildly alkaline (pH 7.6); clear wavy boundary.

3Bt2—14 to 26 inches; pale brown (10YR 6/3) and brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist, dark brown (10YR 4/3) moist and crushed; weak thin platy structure parting to strong very fine angular blocky; hard, firm, very sticky and plastic; few very fine roots; common very fine tubular pores; common distinct clay films on peds and faint clay films in pores; mildly alkaline (pH 7.6); clear wavy boundary.

3C—26 to 60 inches; pale brown (10YR 6/4) silty clay loam, dark brown (10YR 4/3) moist; weak thin platy structure; hard, firm, sticky and plastic; few very fine roots; few very fine tubular pores; few thin cutans on faces of peds; mildly alkaline (pH 7.6).

Depth to bedrock is more than 60 inches. A clay increase of 15 to 25 percent is between the 2A and 3Bt horizons. Some pedons have carbonates below a depth of 40 inches. The particle-size control section is 35 to 50 percent clay.

The A horizon has chroma of 1 or 2 when moist or dry. It is silt loam or gravelly coarse sand. The gravelly coarse sand is about 60 percent pumiceous ash and is as much as 7 inches thick.

The 2A horizon has value of 7 or 8 when dry and 4 or 5 when moist, and it has chroma of 1 or 2 when moist or dry. The horizon is a deposit of ash from Newberry Crater.

The 3Bt horizon has value of 3 to 5 when moist, and it has chroma of 2 to 4 when moist or dry. The upper part of the horizon commonly has uncoated sand and silt grains and tongues of 2A horizon material.

Structure is prismatic or columnar. The horizon is silty clay loam, silty clay, or clay and is 0 to 5 percent gravel. It is neutral to moderately alkaline.

The 3C horizon is silty clay loam or clay loam.

Swalesilver Series

The Swalesilver series consists of very deep, somewhat poorly drained soils in closed basins on lava plains. These soils formed in lacustrine sediment. Slopes are 0 to 1 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Swalesilver loam, 0 to 1 percent slopes; 200 feet east and 1,800 feet south of the northwest corner of sec. 31, T. 22 S., R. 19 E.

A1—0 to 3 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; few fine distinct yellowish red (5YR 4/6) mottles; weak medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine vesicular pores; slightly acid (pH 6.2); abrupt smooth boundary.

2A2—3 to 5 inches; light gray (10YR 7/1) silt loam, gray (10YR 5/1) moist; moderate medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; neutral (pH 7.2); abrupt smooth boundary.

3Bt1—5 to 13 inches; light brownish gray (10YR 6/2) clay, dark grayish brown (10YR 4/2) moist; strong fine angular blocky structure; hard, very firm, sticky and plastic; common fine and medium roots; few fine tubular pores; few thin clay films in pores; many stress surfaces; mildly alkaline (pH 7.5); clear smooth boundary.

3Bt2—13 to 18 inches; light brownish gray (10YR 6/2) clay, dark grayish brown (10YR 4/2) moist; moderate fine angular blocky structure; hard, very firm, very sticky and very plastic; common fine and medium roots; common fine tubular pores; few faint clay films in pores; moderately alkaline (pH 7.8); clear wavy boundary.

3BCk1—18 to 40 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, very firm, slightly sticky and slightly plastic; few fine roots, few fine tubular pores; strongly effervescent; strongly alkaline (pH 8.6); gradual smooth boundary.

3BCk2—40 to 50 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; massive; hard, very firm, slightly sticky and plastic; few fine tubular pores; strongly effervescent; 2 percent seams of light gray lime; strongly alkaline (pH 8.6); clear smooth boundary.

4C—50 to 60 inches; light olive brown (2.5YR 5/4) loam, olive brown (2.5Y 4/4) moist; massive with thin horizontal bedding planes; hard, very firm, slightly sticky and slightly plastic; few fine tubular pores; moderately alkaline (pH 8.0).

Depth to bedrock is more than 60 inches. The particle-size control section is 45 to 60 percent clay.

The A horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 2 when moist or dry. It is slightly acid to mildly alkaline.

The 2A horizon has value of 5 or 6 when moist and 7 or 8 when dry, and it has chroma of 1 or 2 when moist or dry. It is neutral or mildly alkaline.

The 3Bt 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. The horizon is clay or silty clay and is 45 to 65 percent clay.

The 3BCk horizon has hue of 10YR or 2.5Y when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. The horizon is silty clay loam or clay loam and is 30 to 35 percent clay. The upper part of the horizon has disseminated lime, and the lower part has soft concretions of lime. The horizon is mildly alkaline to strongly alkaline.

The 4C horizon has hue of 2.5Y or 5Y when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist. It is stratified loam, silt loam, and clay loam and is 15 to 30 percent clay. The horizon is noncalcareous or slightly calcareous. It is mildly alkaline to strongly alkaline.

Tetherow Series

The Tetherow series consists of excessively drained soils that are shallow or moderately deep to cinders. These soils are on lava plains. They formed in ash over cinders. Slopes are 0 to 50 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Tetherow sandy loam, 0 to 3 percent slopes; 0.5 mile northwest of Terrebonne, adjacent to cinder pit; 1,200 feet south and 300 feet east of the northwest corner of sec. 16, T. 14 S., R. 13 E.

Ap—0 to 6 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; mildly alkaline (pH 7.4); clear smooth boundary.

A—6 to 19 inches; brown (10YR 5/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and few fine irregular pores; 5 percent gravel; mildly alkaline (pH 7.6); clear wavy boundary.
AC—19 to 24 inches; pale brown (10YR 6/3) cobbly sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; few medium subangular concretions; 20 percent cobbles; mildly alkaline (pH 7.4); clear wavy boundary.
2C—24 to 60 inches; cinders that are dark reddish brown (5YR 3/4) moist or dry; single grain.

Depth to bedrock is more than 60 inches. Thickness of the solum and depth to cinders are 14 to 28 inches. The profile is neutral or mildly alkaline.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 5 when dry, and chroma of 2 or 3 when moist or dry. It is 0 to 10 percent gravel.

The AC horizon has chroma of 2 or 3 when moist or dry. It is 0 to 25 percent cobbles and 0 to 10 percent gravel. It is sandy loam or cobbly sandy loam.

The 2C horizon has hue of 10YR or 5YR, value of 3 when moist and 5 or 6 when dry, and chroma of 3 when moist and 3 or 4 when dry. It is 90 to 100 percent cinders (more than 2.0 millimeters). Thin, brittle, discontinuous layers are in some pedons.

Thorn Series

The Thorn series consists of shallow, well drained soils on mountains. These soils formed in ash over colluvium and residuum. Slopes are 15 to 50 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Thorn gravelly sandy loam in an area of Parrego-Thorn-Rock outcrop complex, 15 to 50 percent slopes; on Forest Service Road 1160, 0.5 mile west of the junction with Forest Service Road 1160-410; in the NE$^1/_4$ of sec. 8, T. 12 S., R. 10 E.

Oi—1 inch to 0; ponderosa pine litter and grasses.
A1—0 to 4 inches; dark brown (10YR 3/3) gravelly sandy loam, grayish brown (10YR 5/2) dry; weak medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many fine interstitial pores; 15 percent gravel and 5 percent cobbles; 10 percent clay; neutral (pH 7.0); clear wavy boundary.
2A2—4 to 8 inches; dark brown (10YR 4/3) loam; light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many very fine tubular pores; 12 percent clay; neutral (pH 7.0); clear wavy boundary.
2Btb—8 to 16 inches; dark brown (7.5YR 4/4) extremely cobbly loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, nonsticky and slightly plastic; few coarse roots; common very fine tubular pores; common distinct clay films on peds and rock fragments; 15 percent gravel, 60 percent cobbles, and 20 percent stones; 20 percent clay; neutral (pH 7.2); clear wavy boundary.
2R—16 inches; andesite.

Depth to bedrock is 10 to 20 inches. The profile has hue of 10YR or 7.5YR.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has value of 2 or 3 when moist and 5 or 6 when dry, and it has chroma of 3 when moist and 2 to 4 when dry. The horizon is 5 to 18 percent clay. It is 10 to 25 percent subrounded gravel and 0 to 10 percent subrounded to angular cobbles. Total rock fragment content is 15 to 30 percent.

The 2Btb horizon has chroma of 2 to 4 when moist or dry. It is very cobbly loam, extremely cobbly loam, or extremely stony loam and is 20 to 27 percent clay. The horizon is 10 to 25 percent angular gravel, 20 to 50 percent angular cobbles, and 10 to 40 percent stones. Total rock fragment content is 55 to 80 percent.

A 2Cr horizon is in some pedons. It is 1 to 3 inches thick.

Tub Series

The Tub series consists of deep, well drained soils on north-facing slopes of hills and canyons. These soils formed in loess over colluvium. Slopes are 15 to 60 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Tub loam in an area of Schrier-Tub complex, 30 to 60 percent north slopes; in the NW$^1/_4$SW$^1/_4$NE$^1/_4$ of sec. 31, T. 12 S., R. 13 E.

A1—0 to 2 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine and fine roots; many very fine interstitial pores; neutral (pH 7.2); clear wavy boundary.
A2—2 to 8 inches; dark grayish brown (10YR 4/2)

loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine and fine roots; many very fine interstitial pores; neutral (pH 7.2); gradual wavy boundary.

A3—8 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine and medium roots; many very fine interstitial pores; neutral (pH 7.2); gradual wavy boundary.

Bw—14 to 24 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine and medium roots; many very fine interstitial pores; 10 percent gravel; neutral (pH 7.2); clear wavy boundary.

2Bt—24 to 28 inches; brown (10YR 5/3) very cobbly clay, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine, medium, and coarse roots; common fine interstitial pores and few fine tubular pores; common faint clay films on faces of peds and in pores; 25 percent gravel and 15 percent cobbles; mildly alkaline (pH 7.4); gradual wavy boundary.

2Btk—28 to 41 inches; brown (10YR 5/3) cobbly clay, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky structure; very hard, firm, slightly sticky and plastic; few fine, medium, and coarse roots; common fine interstitial pores and few fine tubular pores; many prominent clay films on faces of peds and in pores; 15 percent gravel and 15 percent cobbles; strongly effervescent with disseminated carbonates and coatings of carbonates on rock fragments; mildly alkaline (pH 7.6); clear irregular boundary.

2R—41 inches; rhyolite.

Depth to bedrock is 40 to 60 inches. Depth to secondary carbonates is 20 to 30 inches. The mollic epipedon is 20 to 25 inches thick. The particle-size control section averages 15 to 35 percent rock fragments.

The A horizon has value of 4 or 5 when dry. It is 20 to 27 percent clay.

The 2Bt horizon has value of 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is very cobbly clay or cobbly clay and is 40 to 60 percent clay.

The 2Btk horizon has value of 3 to 5 when moist and 5 to 7 when dry, and it has chroma of 3 when moist or dry. The horizon is cobbly clay or cobbly clay loam and is 30 to 50 percent clay. It is mildly alkaline or moderately alkaline.

Tumalo Series

The Tumalo series consists of well drained soils that are moderately deep to a duripan. These soils are on outwash plains. They formed in ash over glacial outwash. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Tumalo sandy loam, 0 to 3 percent slopes; 1,600 feet north and 900 feet east of the southwest corner of sec. 30, T. 16 S., R. 12 E.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

A2—3 to 10 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; 10 percent gravel; neutral (pH 7.2); clear smooth boundary.

AB—10 to 18 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; 10 percent gravel; mildly alkaline (pH 7.4); abrupt smooth boundary.

Bw—18 to 32 inches; pale brown (10YR 6/3) very gravelly sandy loam, dark brown (10YR 3/3) moist; moderate medium and coarse subangular blocky structure; hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine interstitial pores; 35 percent gravel; mildly alkaline (pH 7.4); abrupt wavy boundary.

2Bkqm—32 to 44 inches; very pale brown (10YR 7/4) duripan; strongly cemented gravel with indurated laminar capping on surface and in fractures; strongly effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

3C—44 to 90 inches; black (10YR 2/1) and very pale brown (10YR 7/3) extremely gravelly sand, black

(10YR 2/1) and pale brown (10YR 6/3) moist; single grain; loose, nonsticky and nonplastic; 70 percent gravel; neutral (pH 7.2).

Depth to the indurated duripan is 20 to 40 inches. Depth to bedrock is more than 60 inches. The solum is 20 to 60 percent pumice (0.5 to 2.0 millimeters). It is 5 to 10 percent clay and 55 to 75 percent sand.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 or 2 when moist or dry. It is 0 to 10 percent gravel and 0 to 15 percent cobbles and stones. Total rock fragment content is 0 to 15 percent.

The Bw horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. The horizon is gravelly or very gravelly sandy loam and is 15 to 40 percent gravel. It is neutral or mildly alkaline.

The 3C horizon is extremely gravelly or very gravelly sand and is 35 to 70 percent gravel. It is neutral or mildly alkaline.

Tutni Series

The Tutni series consists of very deep, somewhat poorly drained soils on pumice-mantled stream terraces. These soils formed in ash and pumice over colluvium and old alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Tutni loamy coarse sand, 0 to 3 percent slopes; 200 feet west and 300 feet south of the northeast corner of sec. 32, T. 22 S., R. 10 E.

Oi—1 inch to 0; litter of lodgepole pine needles.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, pale brown (10YR 6/3) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 10 percent pumice gravel; slightly acid (pH 6.4); clear smooth boundary.

AC—4 to 10 inches; dark brown (10YR 3/3) loamy coarse sand, pale brown (10YR 6/3) dry; single grain; soft, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; many very fine interstitial pores; 10 percent pumice gravel; neutral (pH 6.8); gradual wavy boundary.

C1—10 to 24 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, light yellowish brown (10YR 6/4) dry; few faint brown (7.5YR 5/4) mottles; single grain; soft, loose, nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; 40 percent pumice gravel; neutral (pH 7.2); gradual wavy boundary.

C2—24 to 43 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, light yellowish brown (10YR 6/4) dry; many faint very dark grayish brown (10YR 3/2) mottles; single grain; soft, loose, nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; 40 percent pumice gravel; neutral (pH 7.2); clear smooth boundary.

2Bwb—43 to 60 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine interstitial pores; 10 percent gravel; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Depth to the 2Bwb horizon is 40 to 60 inches. A water table is at a depth of 18 to 48 inches in April through June.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist or dry. It is 0 to 10 percent pumice gravel.

The AC horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist or dry. It is 0 to 10 percent pumice gravel.

The C horizon has hue of 5YR to 2.5Y, value of 3 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 6 when moist and 2 to 4 when dry. The horizon is 20 to 50 percent pumice gravel. It is loamy coarse sand or coarse sand.

The 2Bwb horizon has chroma of 2 or 3 when moist or dry. It is 0 to 10 percent gravel. The horizon is loam, fine sandy loam, or sandy loam and is 10 to 20 percent clay.

Vergas Series

The Vergas series consists of very deep, well drained soils on lake terraces. These soils formed in old alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Vergas loam, 0 to 3 percent slopes; about 1,100 feet north and 1,500 feet east of the southwest corner of sec. 13, T. 22 S., R. 22 E.

A—0 to 3 inches; light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine vesicular pores; about 10 percent gravel; neutral (pH 7.0); clear wavy boundary.

AB—3 to 5 inches; light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly

hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; about 10 percent gravel; neutral (pH 7.0); clear wavy boundary.

BA—5 to 10 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many fine roots and few medium roots; common very fine tubular pores; about 10 percent gravel; neutral (pH 7.0); gradual wavy boundary.

Bt—10 to 25 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; few fine roots; few very fine tubular pores; about 10 percent gravel; few faint clay films on peds and in pores; mildly alkaline (pH 7.6); clear wavy boundary.

BC—25 to 29 inches; pale brown (10YR 6/3) gravelly loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine tubular pores; about 20 percent gravel; mildly alkaline (pH 7.8); clear smooth boundary.

2Bq—29 to 60 inches; pale brown (10YR 6/3) extremely gravelly loamy sand, dark brown (10YR 4/3) moist; massive; hard, firm and brittle, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; about 60 percent gravel; mildly alkaline (pH 7.8).

Depth to the brittle layer is 20 to 40 inches. Depth to bedrock is more than 60 inches. The profile is neutral or mildly alkaline.

The A horizon has value of 5 or 6 when dry. It is 5 to 15 percent gravel.

The Bt horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry. The horizon is 20 to 30 percent clay and 5 to 35 percent gravel. It is loam, clay loam, or gravelly loam.

The 2Bq horizon is 50 to 80 percent gravel. It is firm or very firm and is brittle. The horizon is very gravelly or extremely gravelly loamy sand.

Wanoga Series

The Wanoga series consists of moderately deep, well drained soils on hills. These soils formed in ash. Slopes are 0 to 50 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of Wanoga sandy loam, 15 to 30 percent slopes; 500 feet east and 500 feet south of the northwest corner of sec. 19, T. 14 S., R. 11 E.

Oi—1 inch to 0; litter of ponderosa pine needles and twigs.

A1—0 to 2 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many fine interstitial pores; 5 percent gravel; neutral (pH 6.8); gradual wavy boundary.

A2—2 to 12 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; many very fine interstitial pores; 5 percent gravel; neutral (pH 6.8); gradual wavy boundary.

Bw—12 to 24 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, medium, and coarse roots; many very fine interstitial pores and few fine tubular pores; 10 percent gravel; neutral (pH 7.0); clear wavy boundary.

2Crqt—24 to 34 inches; weathered tuff; coatings of silica and clay in vesicles; clear wavy boundary.

2R—34 inches; tuff.

Depth to bedrock is 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 when dry. It is 0 to 10 percent gravel.

The Bw horizon has hue of 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It is sandy loam, fine sandy loam, or cobbly sandy loam. It is 0 to 10 percent durinodes and 0 to 25 percent concretions that are very friable when moist. The horizon is 5 to 15 percent gravel and 0 to 15 percent cobbles. Total coarse fragment content is 10 to 30 percent.

The 2Cr horizon has coatings of silica and clay. It has a discontinuous silica cap at the upper boundary in some pedons.

Westbutte Series

The Westbutte series consists of moderately deep, well drained soils on hills and mountains. These soils formed in colluvium derived from basalt or welded tuff with ash in the upper part. Slopes are 5 to 50 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Westbutte stony loam in an area of Stookmoor-Westbutte complex, 25 to 50 percent north slopes; about 6.25 miles north from U.S. Highway 20, on the road that follows Lizard Creek; in roadcut on

southeast side; in the NE¼SE¼NW¼ of sec. 12, T. 21 S., R. 20 E.

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) stony loam, very dark gray (10YR 3/1) moist; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; 5 percent gravel, 10 percent cobbles, and 5 percent stones; neutral (pH 6.8); clear wavy boundary.

A2—9 to 21 inches; dark brown (10YR 3/3) very cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine interstitial pores; 5 percent gravel, 35 percent cobbles, and 10 percent stones; neutral (pH 6.8); clear wavy boundary.

Bw—21 to 30 inches; brown (10YR 5/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine tubular pores; 5 percent gravel, 40 percent cobbles, and 10 percent stones; neutral (pH 6.9); abrupt wavy boundary.

R—30 inches; fractured, welded tuff.

Depth to bedrock is 20 to 40 inches. The profile is neutral or mildly alkaline.

The A horizon has value of 2 or 3 when moist and 3 to 5 when dry, and it has chroma of 1 or 2 when moist or dry. The fine earth fraction is loam and is 0 to 20 percent volcanic ash. Total rock fragment content is 20 to 50 percent.

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. It is loam or clay loam and is 18 to 30 percent clay. Total rock fragment content is 35 to 75 percent.

Wickiup Series

The Wickiup series consists of very deep, poorly drained soils in depressions and swales on pumice-mantled stream terraces. These soils formed in pumice and ash. Slopes are 0 to 3 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Wickiup loamy sand, 0 to 3 percent slopes; 500 feet west and 900 feet south of the northeast corner of the NW¼ of sec. 1, T. 25 S., R. 7 E.

Oi—4 inches to 0; litter of lodgepole pine needles and huckleberry leaves and twigs.

A—0 to 4 inches; light brownish gray (10YR 5/2) loamy sand, light gray (10YR 7/1) dry; few faint very dark grayish brown (10YR 3/2) mottles; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots and few fine and medium roots; many very fine tubular pores; slightly acid (pH 6.4); clear smooth boundary.

C1—4 to 10 inches; yellowish brown (10YR 5/6) very gravelly coarse sand, very pale brown (10YR 7/4) dry; few faint very dark grayish brown (10YR 3/2) mottles; massive; loose, nonsticky and nonplastic; few fine roots; many very fine interstitial pores; 45 percent pumice gravel; slightly acid (pH 6.2); gradual wavy boundary.

C2—10 to 60 inches; yellowish brown (10YR 5/6) extremely gravelly coarse sand, white (10YR 8/2) dry; many distinct yellowish brown (10YR 5/4) mottles; massive; loose, nonsticky and nonplastic; many very fine interstitial pores; 75 percent pumice gravel; slightly acid (pH 6.2).

Depth to bedrock is more than 60 inches.

The A horizon has value of 5 or 6 when moist and 7 or 8 when dry, and it has chroma of 1 or 2 when moist or dry. It has faint dark grayish brown mottles. In some pedons the fine earth fraction includes a significant amount of diatomaceous earth that makes the horizon light colored and fine textured.

The C horizon has hue of 10YR to 5Y, value 5 or 6 when moist and 6 to 8 when dry, and chroma of 4 to 6 when moist or dry. It has faint or distinct dark grayish brown to reddish brown mottles. It is 35 to 90 percent gravel-sized pumice.

Wilt Series

The Wilt series consists of moderately deep, well drained soils on hills. These soils formed in ash over residuum. Slopes are 0 to 15 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Wilt sandy loam, 0 to 15 percent slopes; 1,200 feet south and 200 feet east of the northwest corner of sec. 19, T. 14 S., R. 11 E.

A1—0 to 6 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak thin platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; 15 percent clay; 5 percent gravel; neutral (pH 7.0); gradual smooth boundary.

A2—6 to 13 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many

very fine irregular pores; 15 percent clay; 5 percent gravel; neutral (pH 7.0); gradual wavy boundary.
2Btb1—13 to 26 inches; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, and coarse roots and common medium roots; many fine vesicular pores and few medium tubular pores; few faint clay films on peds and few distinct clay films in pores; 15 percent gravel and 15 percent cobbles; neutral (pH 7.0); abrupt wavy boundary.
2Btb2—26 to 33 inches; dark brown (7.5YR 3/4) very cobbly clay loam, brown (7.5YR 4/4) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; many fine vesicular pores and few fine and medium tubular pores; continuous distinct clay films on peds and in pores; 20 percent gravel and 35 percent cobbles; neutral (pH 7.0); abrupt wavy boundary.
R—33 inches; fractured andesite.

Depth to bedrock is 20 to 40 inches. The particle-size control section is 20 to 35 percent clay and averages 35 to 50 percent coarse fragments.

The A horizon has hue of 10YR, value of 3 when moist and 5 when dry, and chroma of 3 when moist or dry. It is 10 to 20 percent clay and 2 to 10 percent gravel.

The 2Btb horizon has hue of 10YR or 7.5YR, value of 3 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. The upper part of the horizon is cobbly loam or cobbly clay loam, and the lower part is very cobbly clay loam. The horizon is 20 to 35 percent clay. It is 10 to 30 percent gravel and 15 to 40 percent cobbles.

Windego Series

The Windego series consists of very deep, well drained soils on mountains. These soils formed in ash over colluvium. Slopes are 0 to 70 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Windego sandy loam in an area of Windego-Smiling complex, 30 to 50 percent slopes; west of Forest Service Road 14, about 3/4 mile south of intersection with Forest Service Road 1495, about midslope; in the SE1/4 of sec. 3, T. 13 S., R. 9 E.

Oi—1 inch to 0; litter of ponderosa pine needles.
A1—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark brown (10YR 3/3) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many fine interstitial pores; 10 percent gravel; neutral (pH 7.2); clear wavy boundary.
A2—8 to 19 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 4/4) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many fine interstitial pores; 10 percent gravel; neutral (pH 7.2); abrupt wavy boundary.
2Btb1—19 to 30 inches; dark brown (7.5YR 3/4) very cobbly loam, brown (7.5YR 4/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common medium and coarse roots; many fine interstitial and tubular pores; few faint clay films on peds and in pores; 10 percent subrounded gravel and 30 percent subrounded cobbles; neutral (pH 7.2); clear wavy boundary.
3Btb2—30 to 42 inches; dark brown (7.5YR 3/4) very cobbly clay loam, brown (7.5YR 4/4) dry; strong medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine, medium, and coarse roots; many fine tubular pores; common distinct clay films on peds and in pores; 15 percent subrounded gravel and 20 percent subrounded cobbles; neutral (pH 7.0); gradual wavy boundary.
3Btb3—42 to 60 inches; very dark grayish brown (10YR 3/2) very cobbly clay loam, yellowish brown (10YR 5/4) dry; strong fine subangular blocky structure; hard, firm, sticky and plastic; few fine, medium, and coarse roots; common fine tubular pores; many distinct clay films on peds and in pores; 20 percent subrounded gravel and 30 percent subrounded cobbles; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Depth to the buried argillic horizon and thickness of the mantle of ash are 14 to 25 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 to 4 when moist and 3 to 5 when dry, and chroma of 2 to 4 when moist and 3 or 4 when dry. The horizon is 5 to 10 percent gravel and 0 to 10 percent cobbles. Total rock fragment content is 5 to 15 percent. The horizon is 5 to 15 percent clay.

The 2Btb and 3Btb horizons have hue of 5YR to 10YR when moist or dry, value of 3 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist and 4 when dry. The horizons are very cobbly loam, very cobbly clay loam, or extremely cobbly clay loam and

are 18 to 35 percent clay. They are 10 to 30 percent gravel, 20 to 30 percent cobbles, and 0 to 10 percent stones. Total rock fragment content is 35 to 70 percent.

Wizard Series

The Wizard series consists of very deep, somewhat poorly drained soils on outwash plains. These soils formed in ash over glacial outwash. Slopes are 0 to 15 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Wizard sandy loam in an area of Wizard-Allingham complex, 0 to 15 percent slopes; 100 feet southwest of Forest Service Road 1230, about 1/4 mile southeast of the intersection with Forest Service Road 1234; 200 feet north and 1,000 feet east of the southwest corner of sec. 30, T. 12 S., R. 9 E.

Oi—2 inches to 0; litter of Douglas fir, white fir, and ponderosa pine needles.

A1—0 to 7 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, nonsticky and nonplastic; few coarse roots, common fine and medium roots, and many very fine roots; many very fine interstitial pores; 5 percent subrounded gravel; slightly acid (pH 6.4); gradual wavy boundary.

A2—7 to 23 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine and coarse roots and common fine and medium roots; many very fine interstitial pores; 5 percent subrounded gravel; slightly acid (pH 6.4); clear smooth boundary.

2Bwb1—23 to 28 inches; dark yellowish brown (10YR 4/4) cobbly sandy loam, light yellowish brown (10YR 6/4) dry; many coarse distinct dark brown bandlike mottles and common medium prominent strong brown diffuse round mottles; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 10 percent subrounded gravel and 10 percent subrounded cobbles; neutral (pH 6.6); gradual irregular boundary.

2Bwb2—28 to 65 inches; dark yellowish brown (10YR 4/4) very cobbly sandy loam, light yellowish brown (10YR 6/4) dry; many coarse distinct dark brown bandlike mottles and common medium prominent strong brown diffuse round mottles; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 10 percent subrounded gravel, 30 percent subrounded cobbles, and 10 percent subrounded stones; neutral (pH 6.6).

Thickness of the mantle of ash and depth to the glacial outwash material (2Bwb horizon) are 20 to 40 inches. Depth to bedrock is more than 60 inches.

The O horizon is 1 to 3 inches thick except in areas that have been disturbed.

The A horizon has 5 to 15 percent clay. It has 0 to 10 percent subrounded gravel. It is slightly acid or neutral.

The 2Bwb horizon has distinct or prominent mottles. It is cobbly sandy loam, cobbly loam, very cobbly sandy loam, or very cobbly loam and is 10 to 20 percent clay. The horizon is 5 to 25 percent subrounded gravel, 10 to 35 percent subrounded cobbles, and 0 to 15 percent subrounded stones. Total rock fragment content is 15 to 60 percent.

Xerolls

Xerolls consist of shallow to very deep, moderately well drained to somewhat excessively drained soils on hills and slumps. These soils formed in a variety of material derived from volcanic rock and ash. Slopes are 5 to 65 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 48 degrees F.

Representative pedon of Xerolls, 5 to 50 percent slopes, in a roadcut along jeep trail; 650 feet west and 1,000 feet south of the northeast corner of sec. 1, T. 10 S., R. 12 E.

A1—0 to 2 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many very fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

A2—2 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots; many very fine interstitial pores; neutral (pH 7.0); gradual smooth boundary.

A3—6 to 18 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium roots; many very fine tubular pores; 10 percent gravel; moderately alkaline (pH 7.4); clear wavy boundary.

2C—18 to 60 inches; light brownish gray (10YR 6/2)

sandy loam, dark brown (10YR 3/3) moist; massive; hard, firm, nonsticky and nonplastic; many very fine tubular pores; moderately alkaline (pH 7.6).

Depth to bedrock is 10 to 60 inches or more. The profile is 0 to 80 percent rock fragments.

The upper part of the A horizon has hue of 10YR, and the lower part ranges to 7.5YR. The 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 loam or very stony loam.

The 2C horizon, where present, has value of 4 to 6 when moist and 3 to 5 when dry, and it has chroma of 2 or 3 when moist or dry.

Yapoah Series

The Yapoah series consists of very deep, somewhat excessively drained soils on mountains. These soils formed in colluvium that is high in content of ash. Slopes are 0 to 75 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 44 degrees F.

Typical pedon of Yapoah very cobbly loamy sand in an area of Sisters-Yapoah complex, 15 to 30 percent slopes; 500 feet south and 100 feet west of the northeast corner of the NW$^{1}/_{4}$ of sec. 9, T. 17 S., R. 10 E.

Oi—2 inches to 0; ponderosa pine and white fir needles and twigs.

A—0 to 12 inches; dark brown (10YR 3/3) very cobbly loamy sand, brown (10YR 5/3) dry; weak fine granular structure; loose, nonsticky and nonplastic; many very fine and fine roots, common medium roots, and few coarse roots; many very fine interstitial pores; 10 percent subangular gravel and 30 percent subangular cobbles; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); gradual wavy boundary.

C1—12 to 33 inches; dark yellowish brown (10YR 3/4) extremely flaggy loamy sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 10 percent subangular gravel, 50 percent flagstones, and 10 percent stones; 40 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0); gradual wavy boundary.

C2—33 to 60 inches; dark yellowish brown (10YR 3/4) extremely flaggy loamy sand, light yellowish brown (10YR 6/4) dry; single grain; loose, nonsticky and nonplastic; few fine, medium, and coarse roots; many very fine interstitial pores; 10 percent subangular gravel, 50 percent flagstones, and 10 percent stones; 30 percent pumice (0.5 to 2.0 millimeters); neutral (pH 7.0).

Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. The horizon is 10 to 20 percent gravel and 25 to 35 percent cobbles. Total rock ragment content is 35 to 55 percent. The horizon is 25 to 40 percent pumice (0.5 to 2.0 millimeters).

The C horizon has value of 3 to 5 when moist and 5 to 7 when dry, and it has chroma of 4 to 6 when moist or dry. It is very cobbly, extremely cobbly, very flaggy, or extremely flaggy loamy sand. The horizon is 10 to 20 percent gravel, 30 to 50 percent cobbles, and 0 to 10 percent stones. Total rock fragment content is 40 to 80 percent. The horizon is 30 to 60 percent pumice (0.5 to 2.0 millimeters).

Formation of the Soils

Soil is a natural, three-dimensional body on the earth's surface that supports plants. Its characteristics and properties are determined by physical and chemical processes that result from the interaction of five factors—parent material, climate, time, relief, and plant and animal life.

The influence of each factor varies from place to place, and some factors are more dominant than others. The interaction of all the factors determines the kind of soil that forms. Most of the differences in the soils in this survey area are the result of three factors—parent material, climate, and relief.

Parent Material

The characteristics of the parent material in which soils form have a profound initial impact on soil properties. Texture, permeability, bulk density, and fertility of young soils are affected by the nature of the parent material. The influence of parent material on soil formation and development decreases over time.

The soils in this survey area formed in material primarily of volcanic origin. Volcanic material, including basalt, andesite, rhyolite, tuff, pumice, and ash, is common. Substrata of volcaniclastic sediment, such as pumice, ash, and cinders, also are common, especially near the foot slopes of the Cascade Mountains. Soils underlain by glacial outwash and till are in the westernmost parts of Deschutes and Jefferson Counties.

The oldest geologic formations in the survey area, which are 25 to 50 million years old, are in the eastern part of Jefferson County and in small areas in the eastern part of Deschutes County *(5)*. The degree of soil development on the John Day and Clarno Formations reflects long periods of geologic time. The Simas and Tub soils have a high content of clay, most of which has high shrink-swell potential such as does montmorillonite; an argillic or calcic horizon, or both; and high chroma.

Fluvial and lacustrine sediment of the Deschutes Formation, which was deposited 2 to 6 million years ago, underlies much of the Deschutes Basin, from Bend north to Gateway in the northwestern part of Jefferson County *(15)*. The Deschutes Formation consists mainly of volcanic sand, gravel, and silt deposited in horizontal beds or reworked by wind and water. Included within the formation are welded tuff and interbedded lava flows that occur as rimrock on buttes and along canyon walls. The volcanic rock and sediment in the Deschutes Formation is from the Broken Top-Three Sisters area of the High Cascades. Preferential erosion has redeposited the unconsolidated material from the High Cascades onto the slopes of Green Ridge and into the Deschutes Basin *(18)*. Superimposed over these areas is a mantle of volcanic ash deposited during the eruption of Mt. Mazama. The mantle is thickest in the southern part of the survey area and is thin and discontinuous in the northern part.

On Green Ridge, deep and moderately deep, soils such as those of the Gap, Glaze, Prairie, Windego, and Smiling series, have layers of ash over fine-textured buried material derived from the underlying basalt or tuff. In the northeastern part of the survey area are soils that have a fine-textured subsoil, but they have little, if any, volcanic ash in the surface layer. Moderately deep and shallow soils, such as those of the Searles, Holmzie, Madras, and Agency series, are examples. Soils such as those of the Redcliff, Redslide, and Lickskillet series formed along the margins of the rimrock in areas of colluvium and residuum derived from basalt. Era soils formed in old stream channel deposits. These soils are very deep and coarse textured and are underlain by sand and gravel of the Deschutes Formation.

In some areas are erosional remnants of lacustrine deposits of diatomite that have a rolling topography and predictable soil patterns. Buckbert soils, which are deep and medium textured, formed in the depressions containing sediment derived from the surrounding slopes. Lafollette soils are underlain by sand and gravel of the Deschutes Formation. These soils formed on the stream terraces in areas where a mantle of ash about 24 inches thick was blown in or washed in from the uplands. Tetherow soils, which are similar to the

Lafollette soils, are underlain by cinders. The cinder cones west of Terrebonne, in the northern part of Deschutes County, are the source of this material.

The basalt flows near Bend and Redmond issued from vents in Newberry Volcano and High Cascades volcanoes. These flows are among the youngest surfaces in the survey area, having been laid down less than 2 million years ago. Soils on these flows are transitional between the coarse-textured pumice soils of the LaPine Basin and the finer textured soils in the northern part of the area. Varying amounts of volcanic ash have been moved from rock outcroppings and redeposited in depressions. Deschutes and Deskamp soils are in these depressions, and Stukel and Gosney soils are in the slightly higher positions along the margins of the depressions and rock outcroppings. Deskamp and Gosney soils are loamy sand because of their proximity to Mt. Mazama, but Deschutes and Stukel soils are dominantly sandy loam. Houstake soils are similar to the Deschutes soils except that they are deeper to basalt and have more cementation in the lower part of the profile. Statz soils, on older basalt lava flows, exhibit the most soil development. They have a well-developed, silica-cemented duripan.

Soils in the eastern part of the survey area (east of Horse Ridge) are distinctly different from those in the Cascade Range. The soils on plains, benches, and basins are moderately deep to very deep to bedrock or to a duripan. They are high in content of volcanic ash that originated from Newberry Volcano or Mt. Mazama. Soils of the Borobey, Gardone, Milcan, and Stookmoor series are examples. In contrast, the soils of the uplands formed in older material of the Pliocene and Pleistocene. These soils are shallow or moderately deep to bedrock or to a duripan. They typically do not have an influence of volcanic ash on the surface, but they have a fine- or medium-textured argillic horizon that is high in content of montmorillonite. Soils of the Ninemile, Menbo, and Beden series are examples. Lake sediment and windblown material accumulated in the smaller basins and playas. Soils such as those of the Swaler and Swalesilver series are in these basins and playas.

A large deposit of Mt. Mazama ash and pumice is within the broad LaPine Basin, between Newberry Volcano and the Cascade Mountains south of Bend. The basin was formed by basalt flows that dammed the Deschutes River near Benham Falls. The Deschutes and Little Deschutes Rivers meander through the area, indicating that the present base level has existed for a considerable period of time. The soils in this area are porous and have distinctive characteristics, such as low bulk density, low heat capacity, low thermal conductivity, and very high available water capacity. Permeability is rapid or very rapid. The thickness of the mantle of ash, depth to a buried soil, and size of pumice fragments decrease as the distance from Mt. Mazama increases.

At the south end of LaPine Basin, the mantle of ash is as much as 10 feet thick. Lapine soils are on the uplands and pumice plains. These soils typically are coarse-textured ash and pumice throughout, and pumice fragments more than 2 millimeters in diameter make up much of the volume. Further north are the Steiger soils that are similar in texture to the Lapine soils, but they have fewer pumice fragments by volume. The Steiger soils have a loam or sandy loam buried soil at a depth of 40 to 60 inches or more. The Shanahan soils are at the northern end of the basin. These soils have a mantle of ash 20 to 40 inches thick over a buried soil, and the volume of pumice fragments is less than that of the Steiger soils.

Associated with the well drained to excessively well drained Lapine, Steiger, and Shanahan soils are the somewhat poorly drained Wickiup, Tutni, and Sunriver soils, respectively. These soils are on stream terraces between the drainageways and the uplands. They are similar in appearance to the upland soils except that they have mottles in the profile, which indicates the presence of a high water table at times during the year. Within the main drainageways of the Deschutes and Little Deschutes Rivers are poorly drained and very poorly drained soils that have a dark surface layer that varies in texture. These soils were laid down during flooding. Layers of volcanic ash are common in the profile. Another common feature is a layer of diatomite, which is a siliceous sedimentary material that formed from one-celled algae, called diatoms, and has low bulk density. These plants form in cold, shallow lacustrine environments that have a ready source of silica *(11)*.

At least three times in the last 100,000 years, glacial ice has covered the Cascade Mountains. The glacial moraines that formed were then blanketed with volcanic ash and cinders from local sources. The Bott and Minkwell soils typically have 24 inches of volcanic ash from High Cascades volcanoes and other sources over a buried soil of glacial till consisting of extremely cobbly or stony loam or clay loam. Soils such as those of the Belrick and Linksterly series have layers of distinctive scoria or fine ash, or both, from local sources, notably Blue Lake and Sand Mountain. Glacial outwash deposits consisting of cobbles, sand, and gravel have been incised locally by stream channels. These deposits form outwash fans and plains at the lower elevations. Soils that formed on these outwash deposits are differentiated by the thickness of the mantle of ash. The Allingham and

Wizard soils typically have a cobbly, very cobbly, or very gravelly loam or clay loam buried soil at a depth of 20 to 40 inches. The Circle and Suilotem soils have a similar buried soil at a depth of 40 to 60 inches. The Plainview and Tumalo soils formed in moderately extensive deposits of glacial outwash west of Tumalo. These soils are drier, and they exhibit less weathering of the ash than do the more moist Allingham, Wizard, Circle, and Suilotem soils.

Climate

The Cascade Mountains form the western boundary of the survey area and act as a barrier to airmasses moving in from the Pacific Ocean. These mountains separate western Oregon, which has a wetter and milder climate, from eastern Oregon, which has a drier, continental climate.

The two most commonly measured climatic factors influencing soil formation are precipitation and temperature. These factors determine the rate and type of physical and chemical reactions that occur in a soil. In general, precipitation and temperature affect soil development and behavior by controlling chemical reactions, physical processes, and the activity of soil organisms *(13)*.

Three distinct climatic zones based on temperature and precipitation are in the survey area. In the forested foot slopes of the Cascade Mountains, the mean annual precipitation ranges from about 80 inches near the crest of the Cascades to about 25 inches near Sisters. Most of the soils in this zone have a layer of ash or scoria derived from local sources and an underlying buried soil. The water passing through the soil leaches exchangeable bases from the surface layer into the subsoil and concentrates hydrogen and aluminum ions in the surface layer; therefore, reaction (pH) of the surface layer is neutral or slightly acid. These soils have a thin surface layer that is 2 percent organic matter or more. The plant community consists of conifers and evergreen shrubs that produce large amounts of material for decomposition. The rate of decomposition, however, is controlled by a combination of factors, such as cold soil temperature. The content of clay in the mantle of ash generally is quite low, usually less than 10 percent, but it increases dramatically in the soils that have a buried argillic horizon. These residual soils probably were formed in ash and basalt deposited when the climate was warmer and more humid.

To the east of the Cascade Mountains, the mean annual precipitation decreases rapidly. This is the transition zone separating the soils of the mountains from those of the desert. From Sisters east to about the Deschutes River, precipitation ranges from 18 to 25 inches. Soil temperatures are warmer in this zone than in the mountains, reaction (pH) is near neutral throughout the profile, and total exchangeable bases is higher. The vegetation is dominantly shrubs and grasses with fewer conifers; thus, the content of organic matter is much lower. In some areas of rangeland, overgrazing by livestock has reduced the plant cover. In the soils that have a large amount of ash and pumice in the surface layer, fluctuations in the temperature of the surface layer are extreme. This is a result of the light color reflecting solar radiation and the low heat capacity of the porous pumice. The content of clay is low in these soils because the deposits are young, and the weathering of minerals is slow because of the lack of moisture.

The soils in the high desert in the eastern part of the survey area (east of Horse Ridge) have a mean annual precipitation of 8 to 12 inches. The vegetation is shrubs, grasses, and a few trees. The content of organic matter is low. Because of the low precipitation, total exchangeable bases is high and free carbonates occur as nodules in the profile and as coatings on the bedrock and coarse fragments. Reaction (pH) in the surface layer is neutral or slightly alkaline, and alkalinity increases as depth increases. The content of clay is low, and fluctuations in the soil temperature are extreme.

Time

The rate of soil formation is measured by the degree of soil horizonation. The influence of time is measured from “the point in time at which a pedalogically catastrophic event is complete, initiating a new cycle of soil development” *(8)*. The catastrophe may be geologic, such as deposition of new material on an existing soil or uplifting of a land mass, or climatic, such as a major change in environmental conditions. Human activity can also affect soil development.

With few exceptions, soil development in central Oregon can be traced from the Pliocene to the present, which covers a span of about 5 million years *(29)*. Although uplift was already occurring in the Cascade Range, the formation of the High Cascades began with the growth of broad shield volcanoes during the beginning of the Pliocene. Basalt and andesite flows from these volcanoes contributed further to the separation of western and eastern Oregon along a north-south mountain belt. Flows of hot mud and ash and waterborne debris, such as sand, gravel, and boulders, swept down from the volcanoes onto the gentler slopes below. During the following millennia, the growth of the High Cascades continued and the climate

changed to about what it is at present. Conditions were favorable for weathering and translocating soil material. An argillic horizon formed in many soils until they were covered by layers of volcanic ash during the Pleistocene, beginning about 2 million years ago. Most notable and useful as a benchmark for measuring change was the eruption of Mt. Mazama about 6,600 years ago. Ash was deposited from south to north over most of central Oregon. Very little soil development has taken place in this mantle of ash. Thin A horizons have developed, and weakly developed B horizons are apparent from the increased structure (cambic horizon), weak cementation, and chemical weathering of the ash.

During the Pleistocene, large volumes of basalt from the High Cascades volcanoes and Newberry Volcano covered the landscape. Insufficient time has passed for development of horizons in this material. The typical profile of soils in these areas is a layer of ash over bedrock. Some soils have a weakly cemented to indurated duripan as a result of silica being leached and redeposited.

The LaPine Basin is a lake basin that formed as a result of lava flows damming the Deschutes River. It contains a broad expanse of Mt. Mazama pumice and ash deposited over stream or lake deposits of diatomite, peat, silt, and sand. Soil development is very slow because of the sterile nature of the pumice and ash and the cold soil temperatures. Thin A horizons have formed in this material, but there is no evidence of development of B horizons. The mantle of pumice and ash is more than 60 inches thick in the southern part of the basin, but it grades to about 24 inches thick near Bend.

Relief

Relief is the elevations or inequalities of the land surface *(22)*. The main factors of relief taken into account are slope, aspect, elevation, and the site-specific microrelief features. These factors affect soil properties independently and in combination with the other factors of soil formation.

Relief has different effects under different environmental conditions. It modifies the influence of parent material and time affecting the erosion and deposition that takes place. It alters climate by increasing or decreasing effective moisture and temperature; consequently, the kinds and abundance of plants vary with aspect *(8)*.

The Cascade Mountains have had a major influence on soil development in central Oregon. They alter the easterly movement of the moist, warm Pacific airmasses and create a rainshadow on the eastern slopes. Elevation in the survey area ranges from 2,500 feet near Madras in the northern part to nearly 5,000 feet in eastern part.

Slope gradient is an important factor in soil formation. The infiltration of water decreases and the amount of runoff increases as slope increases. Slope gradient and shape are related to the underlying lithology and its age. The broad basalt shield volcanoes of the High Cascades generally have moderately steep or steep slopes that rarely are more than 50 percent. The soils are deep and well drained. The outwash plains typically are gently sloping to strongly sloping. The soils are very deep and well drained and may or may not have discontinuities of gravelly outwash. Landforms of the Pliocene or older, such as Cline Buttes, Pine Mountain, and Juniper Butte, that are composed of andesite and rhyolite have the classic shape of older surfaces, including distinct convex, eroding upper slopes and concave, depositional lower slopes. Soils on the upper slopes may have a significant amount of cobbles and stones, while those on the lower slopes are deep and relatively free of stones. The canyons consist of cliffs, debris slopes, and fans *(29)* The thickness of the soils in the canyons is highly variable because of erosion and deposition, and areas of Rock outcrop and Rubble land are common. The plateaus that form the tops of the basalt flows are nearly level to moderately sloping and have stable surfaces. The soils on the plateaus are shallow to moderately deep and have a developed duripan or argillic horizon. Landforms throughout the survey area are modified by a mantle of volcanic ash that softens the appearance of the landscape.

Aspect, or the direction in which a slope faces, is another important feature of relief. Soils that formed on south-facing slopes usually are warmer and drier, have less biomass, and have a lower organic matter content in the surface layer than those on north-facing slopes.

An interesting phenomenon related to relief, found mainly in the LaPine Basin, is the difference in plant communities that occurs with minor changes in elevation. Frost pockets develop in the depressions because the cold air tends to follow the contour of the landscape. As a result, lodgepole pine grows in the depressions or low areas and ponderosa pine is the dominant species in the higher areas. Lodgepole pine seedlings are more tolerant of the cold temperatures at night and are tolerant of wetness in areas that have a high water table.

Plant and Animal Life

Plants and animals, including man, affect and are affected by the soils. The kinds of plants and animals

present also are influenced by the other soil-forming factors.

Soil micro-organisms decompose much of the dead plant material and aid in recycling nutrients into the soil. Earthworms, ants, and burrowing creatures mix soil horizons in areas of favorable moisture conditions.

Changes in vegetation in the survey area are the result of differences in elevation, temperature, and precipitation. The vegetation in the Cascade Mountains consists of commercial-grade timber species such as Douglas fir and ponderosa pine. Understory vegetation commonly consists of snowbrush, manzanita, and other shrubs and grasses. The decomposing litter results in dark-colored soils that have a thick organic layer on the surface and mineral horizons that are high in bases.

In the forest-range transitional areas, the tree species consist of ponderosa pine and western juniper and the understory vegetation is mainly antelope bitterbrush and sagebrush. The relatively recent deposition of ash, the low precipitation, and the limited amount of organic material produce soils that have a low content of organic matter, are light colored, and have weak structure.

In the LaPine Basin, the soils on the terrace adjacent to the stream channel formed under a plant cover of willow, sedges, forbs, and grasses. These poorly drained soils have a thick organic surface layer over layers of pumice. The soils on the adjacent higher terrace are somewhat poorly drained and support lodgepole pine with an understory of bearberry, strawberry, and long-stemmed clover. These soils have a lower organic matter content than do the soils on the lower terrace.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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.

Alluvial cone. The material washed down the sides of mountains and hills by ephemeral streams and deposited at the mouth of gorges in the form of a moderately steep, conical mass descending equally in all directions from the point of issue.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

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.

Andic soil properties. A collection of physical and chemical properties given in "Keys to Soil Taxonomy" that are the taxonomic criteria for the Andisol order.

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.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

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.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

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.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Blowout. A shallow depression from which all or most of the soil material has been removed by the wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

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

Breaks. The steep and very steep broken land at the border of an upland summit that is dissected by ravines.

Breast height. An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

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.

Butte. An isolated small mountain or hill with steep or precipitous sides and a top variously flat, rounded, or pointed that may be a residual mass isolated by erosion or an exposed volcanic neck.

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

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

Canopy. The leafy crown of trees or shrubs. (See Crown.)

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

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

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.

Channery soil material. Soil material that is, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

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.

Clay depletions. Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax 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.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Cemented bodies with crude internal symmetry organized around a point, a line, or a plane. They typically take the form of concentric layers visible to the naked eye. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up concretions. If formed in place, concretions of iron oxide or manganese oxide are generally considered a type of redoximorphic concentration.

Conglomerate. A coarse grained, clastic rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

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.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

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.

Desert pavement. On a desert surface, a layer of gravel or larger fragments that was emplaced by upward movement of the underlying sediments or that remains after finer particles have been removed by running water or the wind.

Dip slope. A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

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.

Draw. A small stream valley that generally is more open and has broader bottom land than a ravine or gulch.

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.

Duripan. A subsurface horizon that is cemented by silica to the degree that less than 50 percent of the volume of an air-dried fragment slakes in water or acid.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

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.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess sulfur (in tables). Excessive amount of sulfur in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

Extrusive rock. Igneous rock derived from deep-seated molten matter (magma) emplaced on the earth's surface.

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.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

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*.

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, or clay.

Firebreak. Area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

Flaggy soil material. Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

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.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

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.

Glacial till. Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

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.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

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:

O horizon.—An organic layer of fresh and decaying plant residue.

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

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an 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.

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

Hydrologic soil groups. Refers to soils grouped according to their runoff 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.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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.

Iron depletions. Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

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.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

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

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Knoll. A small, low, rounded hill rising above adjacent landforms.

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.

Lava plain. A broad area of level or nearly level land, usually hundreds of square miles in extent, that is underlain by a relatively thin succession of basaltic lava flows resulting from fissure eruptions.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low-residue crops. Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Low strength. The soil is not strong enough to support loads.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

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.

Moraine. An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

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.

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.

Pitting (in tables). Pits caused by melting around ice. They form on the soil after plant cover is removed.

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.

Playa. The generally dry and nearly level lake plain that occupies the lowest parts of closed depressional areas, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff.

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.

Poor filter (in tables). Because of rapid or very rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Reduced matrix. A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a

change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

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.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

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.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

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.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

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.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

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.

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.

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. Technically, the E horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying 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."

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus. Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

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.

Till plain. An extensive area of nearly level to undulating soils underlain by glacial till.

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.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

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.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Volcaniclastic material. Fragmental material that is dominantly clasts of volcanic origin. It includes pyroclastic material and epiclastic deposits derived from volcanic sources as a result of mass movement and stream erosion. Examples are welded tuff and volcanic breccia.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

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.

Windthrow. The uprooting and tipping over of trees by the wind.

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

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A A A

Area of Interest (AOI) | Soil Map | Soil Data Explorer | Download Soils Data | Shopping Cart (Free)

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Map Unit Legend

Upper Deschutes River Area, Oregon, Parts of Deschutes, Jefferson, and Klamath Counties (OR620)

Upper Deschutes River Area, Oregon, Parts of Deschutes, Jefferson, and Klamath Counties (OR620)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
26A	Clinefalls sandy loam, 0 to 3 percent slopes	0.2	0.0%
63C	Holmzie-Searles complex, 0 to 15 percent slopes	594.0	75.3%
71A	LaFollette sandy loam, 0 to 3 percent slopes	20.1	2.5%
101D	Redcliff-	64.8	8.2%

Soil Map

Legend

Scale (not to scale)

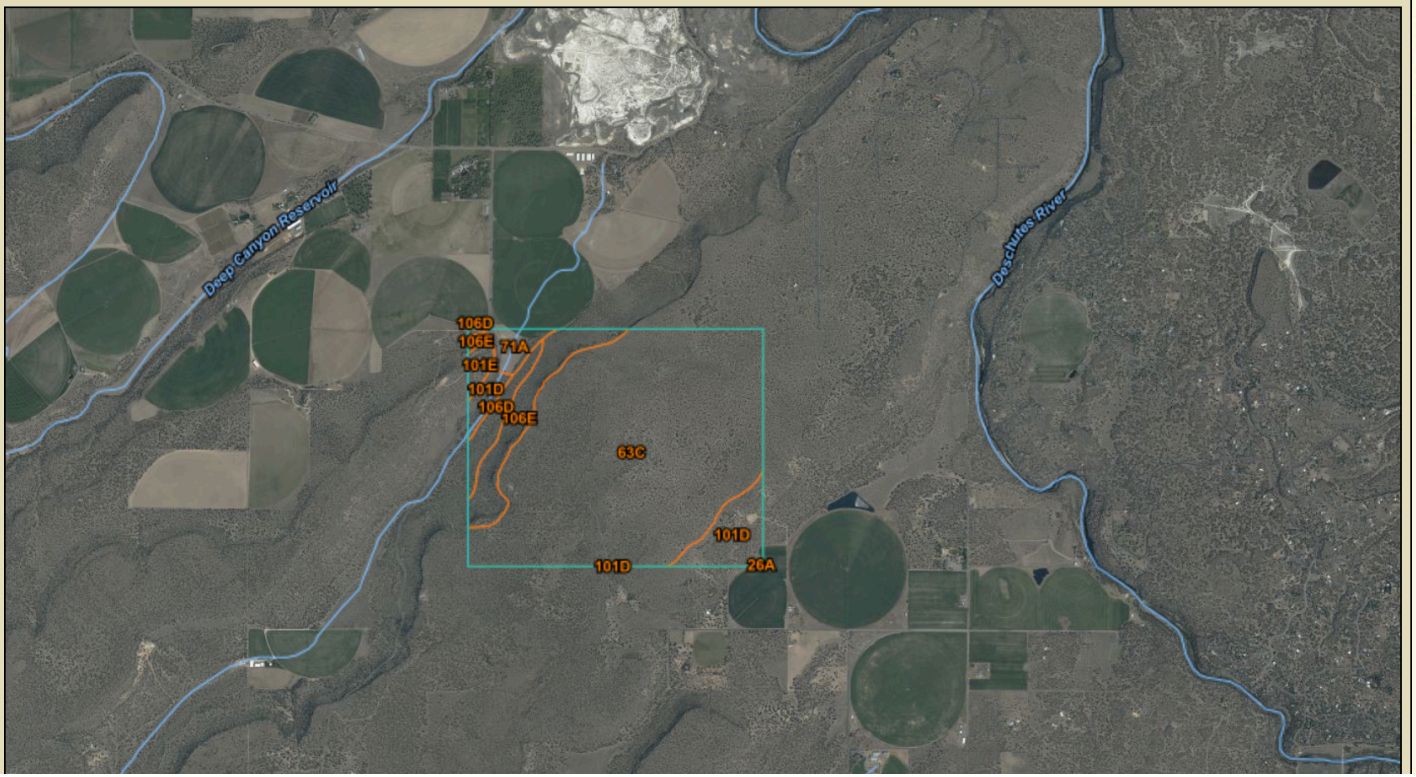

Exhibit B

Upper Deschutes River Area, Oregon, Parts of Deschutes, Jefferson, and Klamath Counties

63C—Holmzie-Searles complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 24f7
Elevation: 2,500 to 3,500 feet
Mean annual precipitation: 9 to 11 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 70 to 90 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Holmzie and similar soils: 50 percent
Searles and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Holmzie

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, nose slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash over residuum weathered from tuff

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 19 inches: clay loam
H3 - 19 to 29 inches: gravelly clay
H4 - 29 to 39 inches: weathered bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R010XA009OR - JUNIPER SHRUBBY PUMICE FLAT 10-12 PZ

Exhibit C

Hydric soil rating: No

Description of Searles

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, nose slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash over residuum weathered from basalt

Typical profile

H1 - 0 to 7 inches: sandy loam
H2 - 7 to 13 inches: loam
H3 - 13 to 15 inches: very gravelly loam
H4 - 15 to 24 inches: very gravelly clay loam
H5 - 24 to 34 inches: unweathered bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R010XA019OR - SHRUBBY LOAM 8-12 PZ
Hydric soil rating: No

Data Source Information

Soil Survey Area: Upper Deschutes River Area, Oregon, Parts of Deschutes, Jefferson, and Klamath Counties
Survey Area Data: Version 19, Oct 27, 2021

TSSH Part 629

Onsite Soil Investigations

Background (629.00)

The National Soil Survey Handbook, Part 655.01(c), provides the following description:

> Site-specific soil investigations, testing, interpretation, and evaluations are services that support the design and installation of works and structures or the implementation of agricultural practices, or that test and evaluate research predictions. These technical soil services are part of NRCS technical assistance to individual cooperators or units of government that have signed agreements specifying the services. The intention of services to individual cooperators is usually to help apply a conservation plan. These are described in general terms in district agreements with NRCS. These services are very site specific and often result in design and practice specifications.

Onsite investigations are not intended to provide information for program eligibility (see site-specific evaluation, NFSAM 512.03).

When site-specific investigations are appropriate (629.01)

NRCS technical soil services for site-specific investigations are done:

- on agricultural lands for USDA program purposes when requested by USDA program participants; or
- through Federal, State, or local forms of government where there is a memorandum of understanding or a cooperative agreement that lists the services to be provided. For more information, see the National Soil Survey Handbook, Part 655.

GM_430 - Title 430 - Soil Survey
402.6 Limitations on Use and Distribution of Soil Survey Information
A. Soil surveys seldom contain detailed site-specific information and are not designed for use as primary regulatory tools in site-specific permitting decisions, but are useful for broad regulatory planning and application. Official Soil Survey Information is public information and may be interpreted by organizations, agencies, units of government, or others based on their own needs; however, users are responsible for the appropriate application of soil survey information. *NRCS will not accept reassignment of authority for decisions made by other Federal, State, or local regulatory bodies. NRCS will not make changes to Official Soil Survey Information, or of any supplemental soil mapping, for purposes related solely to State or local regulatory programs.*

The General Manual, Title 430, Section 402.5F states

> Supplemental mapping provides more detailed soil maps and information for areas of limited extent as a result of more intensive onsite investigations. It is considered a separate soil map developed for specific needs and is maintained for improved documentation of the reliability of the delineations and attribute data of the Official Soil Survey Information. More detailed supplemental soil maps are not considered changes to the Official Soil Survey Information.

Supplemental mapping should only be done to support official NRCS activities, including the implementation of Farm Bill programs and/or Conservation Technical Assistance. It should not be done simply because a cooperator (who has a conservation plan) has a personal need, such as hoping for a better soil potential rating for purposes of selling property.

How site-specific investigations are done (629.02)

Generally, soil survey information is not adequate for site-specific investigations, and point sampling must be done to collect data for a specific use at a specific location. For example, for a manure storage facility, information on depth to the water table and restrictive layers is very important at the location of the proposed facility. Therefore, soil descriptions and interpretations are needed only at the location of the proposed facility.

It is important to understand what data are needed to make the appropriate interpretations for the proposed use before conducting site-specific investigations. This knowledge can facilitate sampling design and ensure that the appropriate data are collected. For information on the characteristics that are important for a conservation practice, refer to the conservation practice standards in the Field Office Technical Guide.

When assisting other units of government with site-specific soils information, consult with the agency to see whether guidelines and criteria are in place. Make any recommendations regarding the soil characteristics that may be important for interpretation for the proposed use if there are no guidelines or criteria or if they are incomplete.

Order 1 soil surveys and site-specific data collected are supplements to the official soil survey, but they do not replace or change the "official" soil survey. In many cases, mapping at an order 1 level or collecting point data may reveal inclusions within map units of soils that were not named in the official soil survey as well as use-dependent soil properties that are different from the typical soil properties listed for map units in the "official" soil survey.

Any change to the official and published soil survey can be made only when the survey area is designated as being an MLRA soil survey update (NSSH Part 610). The resource soil scientist provides documented evidence of the soil characteristics, including pedon descriptions and any transect notes (geospatially located), to the MLRA Project Office Leader. If the onsite investigation is conducted in a non-MLRA project area (e.g., for conservation planning), the findings are also provided to the State Soil Scientist and can then be used to document the need for a future soil survey update. The field determination of HEL orNHEL is provided to the DC and SC.

It is important that any data collected during site-specific investigations be properly captured for multiple and future uses through Pedon PC and uploaded into NASIS where appropriate. Copies of reports should go to the State Soil Scientist.