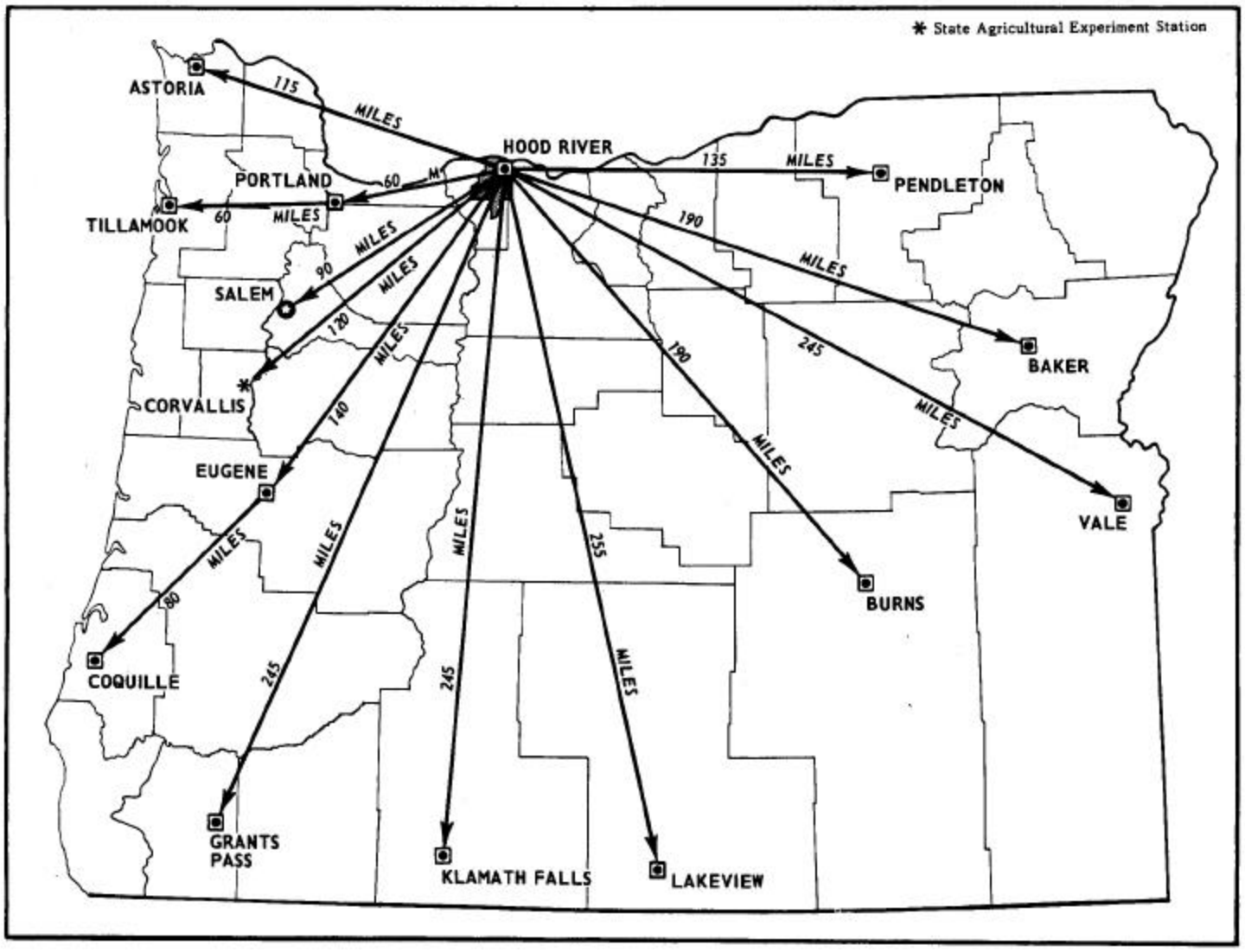

Location of Hood River County Area in Oregon.

SOIL SURVEY OF HOOD RIVER COUNTY AREA, OREGON

BY GEORGE L. GREEN

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

THE HOOD RIVER COUNTY AREA is in the north-central part of Oregon (see facing page). It occupies 118,400 acres.

The survey area is used mainly for farming. Apple and pear production are the principal sources of farm income. Timber products are also a major source of income for the area. Commercial recreation has been limited to associated winter recreation activities. Watershed development has reduced losses from soil erosion and stabilized water supplies.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Hood River County Area, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Dee and Hood, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Hood loam, 0 to 3 percent slope, is one of several phases within the Hood series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Hood River County Area: soil complexes and associations.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Rock outcrop-Bodell-Bald complex is an example.

An association is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils may or may not be uniform. An area shown on the map is made up of all the dominant soils. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by a hyphen. Bins-Bindle association, steep, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Riverwash is a land type in the Hood River County Area.

Some of the mapping units in this survey area are broadly defined. The composition of these units is more variable than the other units in the survey area, but has been controlled well enough to be interpreted for the expected uses of these soils.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Hood River County Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in the Hood River County Area have been grouped into four general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations are described in the following pages.

Warm, Deep, Well Drained and Somewhat Poorly Drained Soils, 0 to 60 Percent Slopes, Formed in Lacustrine, Glacial Outwash, Colluvial and Alluvial Deposits

Four soil associations in the Hood River County Area are on uplands and old terraces, mainly in the northern part. They occupy the lower part of the Hood River Valley, along the Columbia and Hood Rivers. The soils are loamy and are dominantly well drained. They formed in deposits derived mostly from basalt and andesite. Slopes are dominantly less than 12 percent. Elevation is 100 to 2,000 feet. The average annual precipitation is 30 to 45 inches, and the average annual air temperature is 45° to 52° F. The frost-free period is 120 to 210 days.

1. Wind River association

Deep, well drained fine sandy loams; slopes are dominantly less than 8 percent, but range from 0 to 30 percent

This association is on uplands and terraces. The soils formed in moderately coarse and coarse textured old alluvium or outwash. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, bunchgrasses, forbs, and shrubs. Elevation is 200 to 800 feet. The annual precipitation is 30 to 35 inches, and the average annual air temperature is 49° to 52° F. The frost-free period is 150 to 180 days.

This association makes up about 2 percent of the survey area. It is about 64 percent Wind River soils and 36 percent the Wind River variant.

Wind River soils have a surface layer and a subsoil of dark brown fine sandy loam. The substratum is dark yellowish brown fine sandy loam and loamy fine sand. Effective rooting depth is more than 60 inches.

The Wind River variant is dark brown gravelly sandy loam to a depth of about 28 inches. The lower part of the substratum is dark brown very gravelly sand. Effective rooting depth is more than 60 inches.

This association is used for fruit orchards, pasture, and wildlife habitat. It is well supplied with irrigation water from local streams. Apples and pears are the major crops. The wildlife is chiefly upland birds.

Runoff is mainly from areas not protected by vegetation. Soil loss is low. Maintaining a maximum plant cover and conserving soil and water on cropland minimize the hazard of soil erosion.

This association provides good building sites and year-round recreation. It is well suited to farming. It provides only fair food and cover for birds and animals.

2. Hood-Van Horn association

Deep, well drained loams and very fine sandy loams; slopes are dominantly less than 8 percent, but range from 0 to 40 percent

This association is on terraces (fig. 1) . The soils formed in medium textured lacustrine deposits. The vegetation is Douglas-fir, ponderosa pine, bunchgrasses,

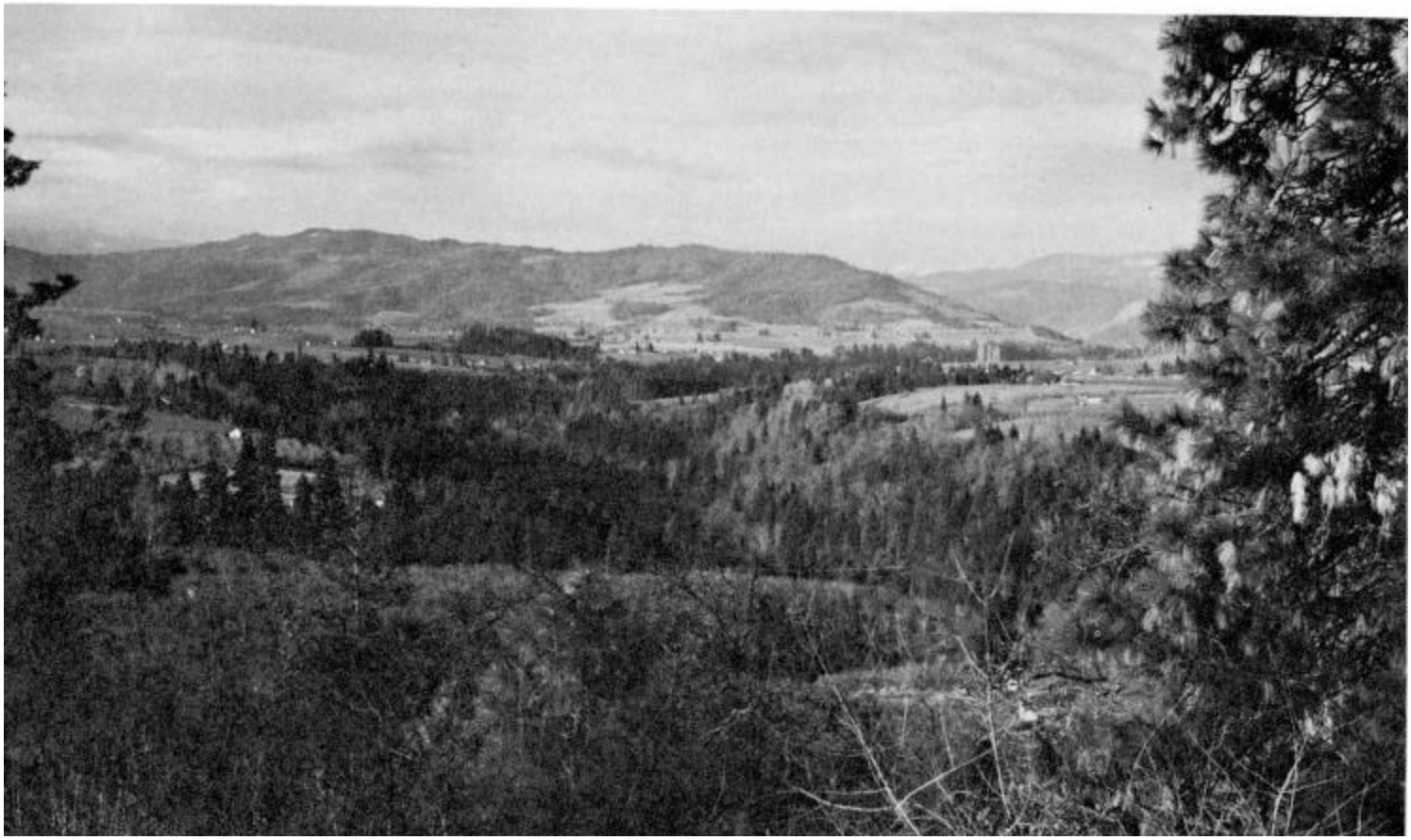

Figure 1.-Xerumbrepts, very steep. On terraces along Hood River are Hood and Van Horn soils. In background on Middle Mountain are Culbertson soils.

forbs, and shrubs. Elevation is 100 to 850 feet. The annual precipitation is 25 to 35 inches, and the average annual air temperature is 49° to 52° F. The frost-free period is 150 to 180 days.

This association makes up about 4 percent of the survey area. It is about 70 percent Hood soils, 20 percent Van Horn soils, and 10 percent Wind River and Wyeast soils.

Hood soils have a surface layer of very dark grayish brown loam and a subsoil of dark brown loam. The substratum is dark brown loam and very fine sandy loam. Effective rooting depth is more than 60 inches.

Van Horn soils have a surface layer of dark brown fine sandy loam and a subsoil of dark brown and dark yellowish brown fine sandy loam and sandy clay loam. The substratum is dark brown sandy loam. Effective rooting depth is more than 60 inches.

This association is used chiefly for fruit orchards and wildlife habitat and to a limited extent for specialty crops. It is well supplied with irrigation water. Apples and pears are the major crops. Wildlife is mainly upland birds.

Runoff is mainly from steep cultivated soils. Soil loss is high. Maintaining a maximum plant cover and conserving soil and water on cropland minimize the hazard of soil erosion.

The association provides good building sites and year-round recreation. It is well suited to farming. It provides only fair food and cover for wildlife.

3. Oak Grove-Rockford association

Deep, well drained loams and stony and very stony loams; slopes are dominantly less than 12 percent, but range from 0 to 60 percent

This association is on terraces and side canyons. The soils formed in deep clayey mudflows and alluvial material and in stony, medium textured and moderately fine textured glacial outwash derived from basalt and andesite. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, bunchgrasses, forbs, and shrubs. Elevation is 100 to 2,000 feet. The annual precipitation is 30 to 45 inches, and the average annual air temperature is 45° to 51° F. The frost-free period is 120 to 180 days.

This association makes up about 12.4 percent of the survey area. It is about 84 percent Oak Grove soils and 16 percent Rockford soils.

Oak Grove soils have a surface layer of dark brown loam and a subsoil of dark brown loam and dark reddish brown clay. Effective rooting depth is more than 60 inches.

Rockford soils have a surface layer of dark brown and dark reddish brown stony loam and cobbly loam and a subsoil of dark reddish brown and dark brown very

cobbly loam. Effective rooting depth is more than 60 inches.

This association is used for fruit orchards, woodland pasture, and wildlife habitat. It is well supplied with irrigation water. Apples and pears are the major crops. Timber production is dominantly in the steeper areas. The wildlife is chiefly upland birds.

Runoff is mainly from moderately steep areas not protected by vegetation. Soil loss is moderate to high. Maintaining a maximum plant cover and conserving soil and water on cropland minimize the hazard of soil erosion.

Limitations are moderate for building sites. The association provides only fair food and cover for birds and animals.

4. Wyeast association

Deep, somewhat poorly drained silt loams; slopes are dominantly less than 8 percent, but range from 0 to 12 percent

This association is on terraces. The soils formed in medium textured lacustrine deposits. The vegetation is Douglas-fir, willow, alders, forbs, and shrubs. Elevation is 500 to 800 feet. The annual precipitation is 30 to 35 inches, and the average annual air temperature is 49° to 51° F. The frost-free period is 150 to 180 days.

This association makes up about 1.3 percent of the survey area. It is about 75 percent Wyeast soils and 25 percent Hood and Van Horn soils and Xerumbrepts.

Wyeast soils have a surface layer of very dark grayish brown and dark brown silt loam and a subsoil of dark brown and brown silt loam and heavy silt loam. The substratum is hard and brittle brown silt loam. Effective rooting depth is 28 to 45 inches.

This association is used for hay, pasture, fruit orchards, and wildlife habitat. It is well supplied with irrigation water. Pears is the major fruit crop. Wildlife is mainly upland birds.

Runoff is mainly from cultivated areas not protected by vegetation. Runoff is slow, but soil loss is high. Maintaining a maximum plant cover minimizes the hazard of soil erosion.

Limitations are severe for building sites and recreational facilities. The association provides only fair food and cover for birds and animals.

Warm, Deep, Well Drained and Somewhat Poorly Drained Soils, 0 to 40 Percent Slopes, Formed in Slightly Weathered Volcanic Ash

One association in the Hood River County Area is on uplands and terraces, mainly in the south-central part. It occupies the upper part of the Hood River Valley, south of Middle Mountain. The soils are loamy. Slopes are dominantly less than 8- percent. Elevation is 1,000 to 2,500 feet. The average annual precipitation is 35 to 45 inches, and the average annual temperature is 45° to 49° F. The frost-free period is 100 to 120 days.

5. Parkdale-Dee association

Deep, well drained and somewhat poorly drained loams and silt loams; slopes are dominantly less than 8 percent, but range from 0 to 40 percent

This association is on terraces and uplands. The soils formed in deep volcanic ash and mudflows high in volcanic ash. The vegetation is Douglas-fir, ponderosa pine, forbs, and shrubs. Elevation is 1,000 to 2,500 feet. The annual precipitation is 35 to 45 inches, and the average annual air temperature is 45° to 49° F. The frost-free period is 100 to 120 days.

This association makes up about 10.6 percent of the survey area. It is about 72 percent Parkdale and 28 percent Dee soils.

Parkdale soils are well drained. They have a dark brown loam surface layer, a brown silt loam subsoil, and a yellowish brown loam substratum. Effective rooting depth is more than 60 inches.

Dee soils are somewhat poorly drained. They have a very dark grayish brown silt loam surface layer, a brown loam subsoil, and a dark yellowish brown sandy loam substratum. Effective rooting depth is 40 to more than 60 inches.

This association is used for fruit orchards, pasture, woodland, and wildlife habitat. It is well supplied with irrigation water. Apples and pears are the major crops. Timber production in the survey area is on the steep canyon slopes. The wildlife is mainly upland birds.

Runoff is mainly from steep soils not protected by vegetation. Soil loss is moderate to high. Maintaining a maximum plant cover minimizes the hazard of soil erosion.

Limitations are slight for building sites on Parkdale soils, but severe on Dee soils because of wetness. The association provides only fair food and cover for birds.

Warm and Cool, Shallow to Deep, Well Drained Soils, Rock Outcrop and Rubble Land, 0 to 75 Percent Slopes; Soils Formed in Volcanic Ash, Loess, and Colluvium

Five associations in the Hood River County Area are on uplands in mountainous areas. The soils are loamy. They formed in deposits derived mostly from basalt and andesite. Slopes are dominantly more than 30 percent. Elevation is 200 to 3,600 feet. The average annual precipitation is 25 to 40 inches, and the average annual air temperature is 42°to 51° F. The frost-free period is 50 to 140 days.

6. Culbertson association

Deep, well drained loams; slopes are dominantly 12 to 20 percent, but range from 0 to 50 percent

The association is on Middle Mountain and on lower foot slopes east and west of the valley area. The soils formed in volcanic ash mixed with loess and stony, moderately fine textured colluvium. The vegetation is Douglas-fir, willow, dogwood, forbs, and low shrubs. Elevation is 400 to 1,800 feet. The annual precipitation is 35 to 40 inches, and the average annual air temperature is 49° to 51° F. The frost-free period is 100 to 120 days.

The association makes up about 6.1 percent of the survey area. It is about 90 percent Culbertson soils and 10 percent Parkdale, Bald, and Wyeth soils.

Culbertson soils have a surface layer of dark brown and dark reddish brown loam and a subsoil of dark reddish brown loam and reddish brown clay loam. The

substratum is reddish brown heavy loam. Effective rooting depth is 40 to 60 inches or more.

This association is used for woodland, fruit orchards, wildlife habitat, and water supply. The supply of irrigation water is limited. The wildlife is mainly deer and upland birds.

Runoff is mainly from moderately steep and very steep soils in recently logged areas. Soil loss is low to moderate. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Limitations are moderate for building site and recreational development. The association provides good food and cover for birds and animals.

7. Bins-Bindle-Ketchly association

Moderately deep and deep, well drained loams, gravelly loams, and cobbly loams; slopes are mostly less than 30 percent, but range from 1 to 70 percent

This association is on uplands in the western and eastern parts of the survey area. The soils formed in wind-lain silts and volcanic ash and in stony colluvium derived from andesite. The vegetation is Douglas-fir, grand fir, ponderosa pine, Oregon white oak, willow, hazel, forbs, and low shrubs. Elevation is 1,100 to 3,600 feet. The annual precipitation is 30 to 40 inches, and the average annual air temperature is 42° to 45° F. The frost-free period is 50 to 100 days.

This association makes up about 16.1 percent of the survey area. It is about 60 percent Bins soils, 25 percent Bindle soils, and 15 percent Ketchly soils.

Bins soils are deep. They have a dark reddish brown gravelly loam surface layer, a dark reddish brown loam and clay loam subsoil, and a dark reddish brown heavy loam substratum. Basalt is at a depth of about 45 inches. Effective rooting depth is 40 to 60 inches or more.

Bindle soils are moderately deep. They have a dark brown gravelly loam surface layer and a dark brown gravelly clay loam subsoil underlain by bedrock. Effective rooting depth is 20 to 40 inches.

Ketchly soils are deep. They have a dark brown loam surface layer and a dark brown and strong brown heavy loam subsoil. Effective rooting depth is 40 to 60 inches.

This association is used for woodland, wildlife habitat, and water supply. The wildlife is mainly deer, elk, bear, and upland birds.

Runoff is mainly from steep soils in recently logged areas. Soil loss is low to moderate. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes and moderately slow permeability make limitations severe for building sites and recreational development. Depth to bedrock is limiting in the Bindle soils. The association provides good food and cover for upland birds and animals.

8. Bins-Bindle association

Moderately deep and deep, well drained gravelly loams; slopes are mostly less than 30 percent, but range from 1 to 70 percent

This association is on uplands on both sides of the Hood River Valley. The soils formed in wind-lain silts and volcanic ash and in stony colluvium derived from andesite and basalt. The vegetation is Douglas-fir, grand fir, ponderosa pine, willow, hazel, vine maple, forbs, and low shrubs. Elevation is 1,100 to 3,600 feet. The annual precipitation is 30 to 40 inches, and the average annual air temperature is 42° to 45° F. The frost-free period is 50 to 100 days.

This association makes up about 7.7 percent of the survey area. It is about 60 percent Bins soils and 40 percent Bindle soils.

Bins soils are deep. They have a dark reddish brown gravelly loam surface layer, a dark reddish brown loam and clay loam subsoil, and a dark reddish brown heavy loam substratum. Effective rooting depth is 40 to 60 inches or more.

Bindle soils are moderately deep. They have a dark brown gravelly loam surface layer and a dark brown gravelly loam and very gravelly clay loam subsoil underlain by bedrock. Effective rooting depth is 20 to 40 inches.

The association is used for woodland, wildlife habitat, and water supply. The wildlife is mainly deer, elk, bear, and upland birds.

Runoff is mainly from very steep soils in recently logged areas. Soil loss is moderate. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes, moderately slow permeability, and coarse fragments make limitations severe for building sites and recreational development. Depth to bedrock is limiting in the Bindle soils. This association provides good food and cover for upland birds and animals.

9. Xerumbrepts-Rock outcrop-Rubble land association

Shallow to deep, well drained soils, Rock outcrop, and Rubble land, all on north- and south-facing canyon slopes and ridges; slopes are dominantly more than 30 percent

The vegetation on this association is Douglas-fir, grand fir, ponderosa pine, broadleaf maple, willow, hazel, vine maple, forbs, and low shrubs. Elevation is 100 to 3,600 feet. The annual precipitation is 30 to 60 inches, and the average annual air temperature is 42° to 51° F. The frost-free period is 30 to 180 days.

This association makes up about 7.7 percent of the survey area. It is about 55 percent Xerumbrepts, 35 percent Rock outcrop and Rubble land, and 10 percent Riverwash, Cumulic Haploxerolls, and Xerofluvents.

Xerumbrepts (fig. 2) range from stone-free to extremely cobbly loams, silt loams, or clay loams. Effective rooting depth is 20 to 60 inches or more.

This association is used for water supply, limited woodland, and wildlife habitat. The wildlife is mainly upland birds. There are a few deer and elk.

Runoff is mainly from very steep soils in recently logged areas. Soil loss is moderate to high. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes, shallowness, the stony surface, and the moderately slow permeability make limitations severe for building sites and recreational development. The as-

Figure 2.-Steep Xerumbrepts along Hood River. Riverwash is along flood plains.

sociation provides good food and cover for upland birds and animals.

10. Bald-Bodell association

Moderately deep and shallow, well drained cobbly loams, 5 to 45 percent slopes, and very cobbly loams, 45 to 75 percent slopes

This association is on uplands on Middle Mountain and on side slopes east of the Hood River Valley. The soils formed in mixed loess and volcanic ash, and in colluvium weathered from basalt. The vegetation is Douglas-fir, Oregon white oak, oceanspray, hazel, forbs, and low shrubs on Bald soils and open grasslands on Bodell soils. Elevation is 200 to 3,000 feet. The annual precipitation is 25 to 40 inches, and the average annual air temperature is 48° to 51° F. The frost-free period is 100 to 140 days.

This association makes up about 9.7 percent of the survey area. It is about 76 percent Bald soils and 24 percent Bodell soils.

Bald soils are moderately deep. They have a dark brown cobbly loam and dark reddish brown very cobbly loam surface layer and a dark reddish brown and reddish brown very cobbly loam subsoil underlain by basalt. Effective rooting depth is 20 to 40 inches.

Bodell soils are shallow. They have a dark brown cobbly loam surface layer and a dark brown very cobbly loam and very cobbly clay loam subsoil underlain by basalt. Effective rooting depth is 12 to 20 inches.

The Bald soils are used for woodland, water supply, and wildlife habitat. The Bodell soils are used for wildlife habitat and water supply. The wildlife is mainly deer and upland birds. Elk sometimes winter in areas of Bald soils.

Runoff is mainly from very steep Bald soils in recently logged areas. Soil loss is moderate. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes and depth to bedrock make limitations severe for building sites and recreational development. The association provides good food and cover for upland birds and animals.

Cool and Cold, Deep, Well Drained Soils, 0 to 65 Percent Slopes, Formed in Volcanic Ash and Colluvium

Four soil associations in the Hood River County Area are in the south-western part, on the broad foot

slopes of Mt. Hood. The soils are loamy. They formed in deposits derived mostly from basalt and andesite. Elevation is 1,500 to 4,800 feet. The average annual precipitation is 40 to 90 inches, and the average annual air temperature is 38° to 42° F. The frost-free period is 30 to 60 days.

11. Yallani association

Deep, well drained stony loams; 8 to 65 percent slopes

This association is on canyonsides and uplands. The soils formed in volcanic ash and in stony colluvium weathered from andesite and basalt. The vegetation is Douglas-fir, grand fir, bigleaf maple, vine maple, forbs, and low shrubs. Elevation is 1,800 to 3,000 feet. The annual precipitation is 40 to 60 inches, and the average annual air temperature is 42° to 45° F. The frost-free period is 30 to 60 days.

This association makes up about 12.2 percent of the survey area. It is about 90 percent Yallani soils and 10 percent Divers and Hutson soils.

Yallani soils have a dark brown stony loam surface layer, a dark brown and dark reddish brown very gravelly loam subsoil, and a dark brown very gravelly loam substratum. Effective rooting depth is more than 60 inches.

This association is used for wildlife habitat, woodland, and water supply. The wildlife is mainly elk, deer, bear, and upland birds.

Runoff is mainly from recently logged areas. Soil loss is moderate to high. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails .and conserving soil and water minimize the hazard of soil erosion.

Steep slopes and coarse fragments are severe limitations for building sites and recreational development. This association provides good food and cover for upland birds and animals.

12. Divers association

Deep, well drained gravelly loams; 3 to 65 percent slopes

This association is on uplands. The soils formed in volcanic ash and mudflows and in colluvial material weathered from basalt and andesite. The vegetation is western hemlock, grand fir, noble fir, white pine, vine maple, huckleberry, rhododendron, forbs, and low shrubs. Elevation is 3,000 to 4,800 feet. The annual precipitation is 50 to 90 inches, and the average annual air temperature is 38° to 42° F. The frost-free period is 30 to 60 days.

This association makes up about 3.6 percent of the survey area. It is about 90 percent Divers soils and 10 percent Yallani and Hutson soils.

Divers soils have a dark brown gravelly loam surface layer, a dark brown and reddish brown gravelly loam subsoil, and an extremely stony loam substratum. Effective rooting depth is 40 to 60 inches.

This association is used for woodland, wildlife habitat, and water supply. The wildlife is mainly elk, deer, bear, and upland birds.

Runoff is mainly from recently logged areas. Soil loss is moderate. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes and coarse fragments make limitations severe for building sites and recreational development. The association provides good food and cover for upland birds and animals.

13. Divers-Hutson association

Deep, well drained fine sandy loams and gravelly loams; 0 to 65 percent slopes

This association is on canyonsides in the uplands. The soils formed in volcanic ash and in mixed colluvium weathered from andesite and basalt. The vegetation is western hemlock, grand fir, white pine, noble fir, Douglas-fir, vine maple, rhododendron, forbs, and low shrubs. Elevation is 2,400 to 4,800 feet. The annual precipitation is 50 to 90 inches, and the average annual air temperature is 38° to 42° F. The frost-free period is 30 to 60 days.

This association makes up about 2.4 percent of the survey area. It is about 75 percent Divers soils, and about 25 percent Hutson soils.

Divers soils have a dark brown gravelly loam surface layer, a dark brown and reddish brown gravelly loam subsoil, and an extremely stony loam substratum. Effective rooting depth is 40 to 60 inches or more.

Hutson soils have a dark brown fine sandy loam surface layer, a yellowish red and dark brown fine sandy loam subsoil, and a reddish brown loam substratum. Effective rooting depth is 40 to 60 inches or more.

This association is used for woodland, wildlife, and water supply. The wildlife is mainly elk, deer, bear, and upland birds.

Runoff is mainly from recently logged areas. Soil loss is moderate to high. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes and coarse fragments are severe limitations for building sites and recreational development. The association provides good food and cover for upland birds and animals.

14. Hutson-Divers association

Deep, well drained fine sandy loams and gravelly loams; 0 to 65 percent slopes

This association occurs on uplands. Soils formed in volcanic ash and in mixed colluvium weathered from andesite and basalt. The vegetation is western hemlock, grand fir, white pine, noble fir, Douglas-fir, vine maple, rhododendron, forbs, and low shrubs. Elevation is 2,400 to 4,800 feet. The annual precipitation is 50 to 90 inches, and the average annual air temperature is 38° to 42° F. The frost-free period is 30 to 60 days.

This association makes up about 4.2 percent of the survey area. It is about 80 percent Hutson soils and about 20 percent Divers soils.

Hutson soils have a dark brown fine sandy loam subsoil, and a reddish brown loam substratum. Effective rooting depth is 40 to 60 inches or more.

Divers soils have a dark brown gravelly loam surface layer, a dark brown and reddish brown gravelly loam subsoil, and an extremely stony loam substratum. Effective rooting depth is 40 to 60 inches or more.

This association is used for woodland, wildlife habitat, and water supply. The wildlife is mainly elk, deer, bear, and upland birds.

Runoff is mainly from recently logged areas. Soil loss is moderate to high. Maintaining a maximum plant cover in logged areas and on logging roads and skid trails and conserving soil and water minimize the hazard of soil erosion.

Steep slopes and coarse fragments are severe limitations for building sites and recreational development.

This association provides good food and cover for upland birds and animals.

Descriptions of the Soils

This part of the survey describes the soil series and mapping units in the Hood River County Area. Each soil series is described in detail, and then briefly each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Cumulic Haploxerolls, for example, do not belong to a soil series, but nevertheless, are listed in alphabetic order with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, wildlife group, and woodland group to which the mapping unit has been assigned. The page for the description of each capability unit, woodland group, or other interpretative group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual.

Bald Series

The Bald series consists of well drained soils on uplands. These soils formed in mixed loess, volcanic ash, and colluvium weathered from basalt. Slopes are 5 to 75 percent. Elevation is 200 to 3,000 feet. The vegetation is oak, pine, fir, bunchgrasses, forbs, and shrubs. The dominant understory plants are elk sedge, blue wildrye, arrowleaf balsamroot, tall oregongrape, deerbrush, common snowberry, and western hazel. Average annual precipitation is 25 to 40 inches, average annual air temperature is 48° to 51° F., and the frost-free period is 100 to 140 days.

In a representative profile the surface layer is dark brown cobbly loam and dark reddish brown cobbly loam about 12 inches thick. The subsoil is dark reddish brown and reddish brown very cobbly loam about 24 inches thick. Basalt is at a depth of about 36 inches. The soil is neutral in the surface layer to slightly acid in the subsoil.

Permeability is moderate. Available water capacity is 2 to 5 inches. Water-supplying capacity is 12 to 15 inches. Effective rooting depth is 20 to 40 inches.

Bald soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Bald cobbly loam, 5 to 45 percent slopes, on Middle Mountain road in NE1/4NE1/4SE1/4 sec. 16, T. 1 N., R. 10 E.

Ol-1/2 inch to 0; oak leaves, pine twigs and needles.

Al-0 to 6 inches; dark brown (7.5YR 3/2) cobbly loam, reddish brown (5YR 4/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 15 percent pebbles, 15 percent cobbles, 5 percent stones; neutral; clear smooth boundary.

A12-6 to 12 inches; dark reddish brown (5YR 3/3) very cobbly loam, reddish brown (5YR 4/4) dry; weak medium subangular blocky structure, slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 20 percent pebbles, 40 percent cobbles; slightly acid; gradual wavy boundary.

B21-12 to 20 inches; dark reddish brown (5YR 3/4) very cobbly loam, reddish brown (5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 20 percent pebbles, 40 percent cobbles; slightly acid; gradual wavy boundary.

B22-20 to 36 inches; reddish brown (5YR 4/4) very cobbly loam, reddish brown (5YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 25 percent pebbles, 50 percent cobbles; slightly acid; abrupt wavy boundary.

IIR-36 inches; basalt, partly fractured.

The A horizon is 15 to 45 percent rock fragments. The B2 horizon is loam, heavy loam, or light clay loam that is more than 35 percent cobbles and pebbles. The structure is weak to moderate fine to medium subangular blocky. Depth to bedrock is 20 to 40 inches.

1E-Bald cobbly loam, 5 to 45 percent slopes. This soil occurs as irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series. A representative mapping unit is in the NE1/4NE1/4SE1/4 sec. 16, T. 1 N., R. 10 E. Included in mapping were areas of Bodell, Culbertson, and Wamic soils that make up about 15 percent of the mapping unit.

Runoff is slow to rapid, and the hazard of erosion is

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

slight to high. Capability subclass VIs; woodland suitability group 4f5 ; wildlife group 2.

2F-Bald very cobbly loam, 45 to 75 percent slopes.

This very steep soil occurs as long, narrow areas and has south-facing slopes. It has a profile similar to the one described as representative of the series, but the surface layer is more than 50 percent rock fragments.

A representative mapping unit is in the SE1/4SE1/4SE1/4 sec. 5, T. 1 N., R. 10 E. Included in mapping were areas of Bodell, Culbertson, and Wamic soils that make up about 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIs ; woodland suitability group 4f6; wildlife group 2.

Bindle Series

The Bindle series consists of well drained soils on uplands. These soils formed in windlain silts, volcanic ash, and stony colluvium weathered from andesite and basalt. Slopes are 1 to 70 percent. Elevation is 2,500 to 3,500 feet. The vegetation is Douglas-fir, grand fir, bunchgrasses, forbs, and shrubs. The dominant understory plants are western fescue, mountain brome, white hawkweed, Cascade oregongrape, shinyleaf spirea, common snowberry, thimbleberry, creambush oceanspray, western hazel, and vine maple. Average annual precipitation is 30 to 40 inches, average annual air temperature is 42° to 45° F., and the frost-free period is 50 to 100 days.

In a representative profile the surface layer is dark brown gravelly loam about 6 inches thick. The upper 7 inches of the subsoil is dark brown gravelly loam. The lower 9 inches is dark brown very gravelly clay loam. The depth to highly fractured bedrock is 20 to 40 inches. The soil is neutral in the surface layer and slightly acid in the subsoil.

Permeability is moderate. Available water capacity is 2 to 5 inches. Water-supplying capacity is 13 to 20 inches. Effective rooting depth is 20 to 40 inches.

Bindle soils are used for woodland, wildlife habitat, and water supply.

The Bindle soils in the Hood River survey area are mapped only with Bins soils.

Representative profile of Bindle gravelly loam in an area of Bins-Bindle association, very steep, south of road in NE1/4SW1/4 sec. 23, T. 1 N., R. 10 E.

O1-1 1/2 inches to 0; fir twigs and needles.

A1-0 to 6 inches; dark brown (7.5YR 3/2) gravelly loam, brown (7.5YR 5/3) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few medium roots; many very fine irregular pores; 20 percent pebbles, 5 percent cobbles; neutral; clear smooth boundary.

B21-6 to 13 inches; dark brown (7.5YR 3/3) gravelly loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few medium roots; many very fine tubular pores; 20 percent pebbles, 5 percent cobbles; slightly acid; gradual wavy boundary.

B22-13 to 22 inches; dark brown (7.5YR 4/3) very gravelly clay loam, brown (7.5YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and medium roots; many very fine tubular pores; 45 percent pebbles, 10 percent cobbles; slightly acid; abrupt irregular boundary.

IIR-22 inches; highly fractured bedrock.

The A horizon is reddish brown or brown when dry and dark brown or dark reddish brown when moist. It is 20 to 40 percent fine pebbles and concretions i/a to 1/z inch in diameter and up to 10 percent stones. The B horizon is reddish brown or brown when dry and dark reddish brown or dark brown when moist. It is 20 to 40 percent pebbles, 5 to 20 percent cobbles, and 5 to 10 percent stones. Depth to highly fractured bedrock is 20 to 40 inches.

Bins Series

The Bins series consists of well drained soils on uplands. These soils formed in windlain silts, volcanic ash, and stony, moderately fine textured colluvium weathered from andesite. Slopes are 1 to 70 percent. Elevation is 1,100 to 3,600 feet. The vegetation is Douglas-fir, grand fir, forbs, and shrubs. The dominant understory plants are western fescue, mountain brome, starflower, strawberry, Cascade oregongrape, shinyleaf spirea, common snowberry, western hazel, and vine maple. Average annual precipitation is 30 to 40 inches, average annual air temperature is 42° to 45° F., and the frost-free period is 50 to 100 days.

In a representative profile the surface layer is dark reddish brown gravelly loam about 13 inches thick. The subsoil is dark reddish brown loam and clay loam about 20 inches thick. The substratum is dark reddish brown heavy loam about 12 inches thick. Weathered andesite is at a depth of about 45 to 60 inches. The soil is slightly acid to medium acid in the surface layer, medium acid to strongly acid in the subsoil, and strongly acid in the substratum.

Permeability is moderately slow. Available water capacity is 7 to 12 inches. Water-supplying capacity is 17 to 20 inches. Effective rooting depth is 40 to 60 inches or more.

Bins soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Bins gravelly loam in an area of Bins-Bindle association, steep, 1 3/4 miles from the Kingsley Ranch on Green Point Reservoir road, 50 feet southwest of road in SE1/4SW1/4 sec. 23, T. 2 N., R. 9 E.

O1-1 inch to 0; fir twigs, and needles.

A11-0 to 1 inches; dark reddish brown (5YR 2/2) gravelly loam, dark reddish gray (5YR 4/2) dry ; weak medium granular structure; soft, very friable, nonstick and nonplastic; many roots; many fine irregular pores; 25 percent fine pebbles; slightly acid; abrupt smooth boundary.

A12-1 to 13 inches; dark reddish brown (5YR 3/3) gravelly loam, reddish brown (5YR 4/3) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; many fine irregular pores; 30 percent pebbles; medium acid; gradual smooth boundary.

Bl-13 to 19 inches; dark reddish brown (5YR 3/4) loam, reddish brown (5YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots many very fine tubular pores; 3 percent pebbles and 2 percent cobbles; medium acid; gradual wavy boundary.

B2-19 to 33 inches; dark reddish .brown (5YR 3,/4) clay loam, reddish brown (5YR 5/3) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; common roots; many very fine tubular pores; 5 percent pebbles and 5 percent cobbles; strongly acid; gradual wavy boundary.

IICl-33 to 45 inches; dark reddish brown (2.5YR and 5YR 3/4) heavy loam, reddish brown (2.5YR 5/4) dry; massive; hard, firm, sticky and slightly plastic; common weathered andesitic fragments 2 to 15 inches in diameter; few roots; common very fine and fine pores; common white flecks; strongly acid; abrupt wavy boundary.

IIC2-45 to 60 inches; dark red (2.5YR 3/6) weathered andesite of loam texture.

The A horizon is dark reddish gray or reddish brown when dry. It is 15 to 25 percent fine pebbles 1/8 to 1/2 inch in diameter and 0 to 15 percent cobbes and stones. The B and C horizons are loam, heavy loam, or clay loam that is 0 to 15 percent pebbles and 0 to 20 percent cobbles. Depth to bedrock is 40 to 60 inches or more.

3E-Bins-Bindle association, steep. This mapping unit is about 55 percent a Bins gravelly loam, slopes of 1 to 30 percent, and 30 percent a Bindle gravelly loam,

slopes of 1 to 30 percent. Some areas at the east side of the survey area are up to 50 percent Bindle gravelly loam. The Bins soil occurs as irregularly shaped areas on broad ridgetops that are not capped by rock. The Bindle soil is on narrow ridges and the upper parts of slopes that are capped by rock. The Bins soil has the profile described as representative of the series. The Bindle soil has a profile similar to the one described as representative of the series, but has a gravelly . loam surface layer. A representative mapping unit is in the SE1/4SW1/4 sec. 23, T. 2 N., R. 9 E.

Included with the soils in mapping were areas of very stony shallow soils, ashy soils, and Rock outcrop. These included areas make up as much as 15 percent of this mapping unit.

Runoff is slow, and the hazard of erosion is slight. Wildlife group 2. Bins soil in capability subclass VIe and woodland suitability group 4o1. Bindle soil in subclass VIs and woodland group 4f1.

3F-Bins-Bindle association, very steep. This mapping unit is about 45 percent a Bins gravelly loam, slopes of 30 to 70 percent, and 40 percent a Bindle cobbly loam, slopes of 30 to 70 percent. Some areas at the east side of the survey area are up to 50 percent the Bindle gravelly loam. The Bins soil is at mid slope and on the lower parts of slopes that are not capped by rock. The Bindle soil is on the tops and convex parts of slopes that are capped by rock. The Bins soil has a profile similar to the one described as representative of the series, but the percentage of rock fragments is higher. A representative mapping unit is in the SW1/4NW1/4 sec. 19, T. 1 N., R. 11 E.

Included with this soil in mapping were areas of shallow very stony soils, Yallani and Wyeth soils, and Rock outcrop. These included soils make up as much as 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Wildlife group 2. Bins soil in capability subclass VIIe and woodland suitability group 4r1. Bindle soil in subclass VIIs and woodland group 4f2.

Bodell Series

The Bodell series consists of well drained soils on uplands. These soils formed in mixed loess, volcanic ash, and colluvium weathered from basalt. Slopes are 5 to 75 percent. Elevation is 200 to 2,500 feet. The vegetation is bunchgrasses, forbs, shrubs, and scattered oak trees. The dominant understory plants are Idaho fescue, bluebunch wheatgrass, letterman needlegrass, Sandberg bluegrass, Oregon bluegrass, prairie junegrass, arrowleaf balsamroot, buckwheat, purple leptotaenia, bighead clover, and yarrow. Average annual precipitation is 25 to 40 inches the average annual air temperature is 48° to 51° F., and the frost-free period is 100 to 140 days.

In a representative profile the surface layer is dark brown cobbly loam about 3 inches thick. The upper 6 inches of the subsoil is dark brown very cobbly loam. The lower 8 inches is dark brown very cobbly clay loam. Basalt is at a depth of 17 inches. The soil is neutral.

Permeability is moderate: Available water capacity is 1 to 2 inches. Water-supplying capacity is 4 to 7 inches. Effective rooting depth is 12 to 20 inches.

Bodell soils are used for wildlife habitat and water supply.

Representative profile of Bodell cobbly loam, 5 to 45 percent slopes, 10 feet north of road in SE1/4SE1/4 sec. 5, T. 2 N., R. 11 E.

A1-0 to 3 inches; dark brown (7.5YR 3/2) cobbly loam, brown (7.5YR 4/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 20 percent pebbles, 20 percent cobbles; neutral; abrupt smooth boundary.

B21-3 to 9 inches; dark brown (7.5YR 3/2) verb cobbly loam, brown (7.5YR 4/3) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular and irregular pores; 10 percent pebbles, 40 percent cobbles; neutral; clear smooth boundary.

B22-9 to 17 inches; dark brown (7.5YR 3/3) very cobbly clay loam, brown (7.5YR 4/3) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; plentiful very fine roots; many very fine irregular and tubular pores; 60 percent cobbles; 10 percent stones; neutral; abrupt smooth boundary.

IIR-17 inches; basalt.

The A horizon is brown, grayish brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. It is 10 to 30 percent pebbles and 20 to 30 percent cobbles. The B2 horizon is brown or dark yellowish brown when moist. The texture is very cobbly loam to very cobbly clay loam that is 18 to 30 percent clay. The B2 horizon is 50 to 70 percent rock fragments, mostly cobbles. Depth to bedrock is 12 to 20 inches.

4E-Bodell cobbly loam, 5 to 45 percent slopes. This soil occurs as irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series. A representative mapping unit is in the SE1/4SE1/4 sec. 31, T. 2 N., R. 11 E. Included in mapping were areas of Bald, Ketchly, and Wamic soils that make up as much as 15 percent of the mapping unit.

Runoff is slow to rapid, and the hazard of erosion is slight to high. Capability subclass VIs; wildlife group **2.**

5F-Bodell very cobbly loam, 45 to 75 percent slopes. This very steep soil occurs as long, narrow areas and has south-facing slopes. It has a profile similar to that described as representative of the series, but the surface layer is more than 50 percent rock fragments. A representative mapping unit is in the SW1/4SW1/4, sec. 5, T. 2 N., R. 11 E. Included in mapping were areas of Bald, Ketchly, and Wamic soils that make up as much as 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIs; wildlife group 2.

Culbertson Series

The Culbertson series consists of well drained soils on uplands. These soils formed in volcanic ash mixed with loess and stony moderately fine textured colluvium. Slopes are 0 to 50 percent. Elevation is 400 to 1,800 feet. The vegetation is Douglas-fir, chinquapin, maple, willow, and bunchgrasses. The dominant understory plants are mountain brome, blue wildrye, tall oregongrape, trailing blackberry, common snowberry, deerbrush, and western hazel. Average annual precipitation is 35 to 40 inches, the average annual air tem-

perature is 49° to 51° F., and the frost-free period is 100 to 120 days.

In a representative profile the surface layer is dark brown and dark reddish brown loam about 12 inches thick. The upper 10 inches of the subsoil is dark reddish brown loam. The lower 19 inches is reddish brown clay loam. The substratum to 60 inches or more is reddish brown heavy loam. The soil is slightly acid.

Permeability is moderately slow. Available water capacity is 9 to 11 inches. Water-supplying capacity is 14 to 17 inches. Effective rooting depth is 40 to 60 inches or more.

Culbertson soils are used for woodland, fruit orchards, grazing, and wildlife habitat.

Representative profile of Culbertson loam, 12 to 20 percent slopes, in NE1/4SE1/4SE1/4 sec. 3, T. 1 N., R. 10 E.

A1-0 to 5 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 10 percent shot 2-5 millimeters in diameter; slightly acid; abrupt smooth boundary.

A3-5 to 12 inches; dark reddish brown (5YR 3/3) loam, brown (7.5YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 10 percent shot 2-5 millimeters in diameter; slightly acid; clear wavy boundary.

B1-12 to 22 inches; dark reddish brown (5YR 3/4) loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; 5 percent shot 2-5 millimeters in diameter; slightly acid; clear wavy boundary.

B2-22 to 41 inches; reddish brown (5YR 4/4) clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; very hard, firm sticky and plastic; few very fine roots; common very fine tubular pores; 30 percent clay; slightly acid; gradual wavy boundary.

C-41 to 60 inches; reddish brown (5YR 4/4) heavy loam, brown (7.5YR 5/4) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; slightly acid.

The A horizon is brown or reddish brown when dry. It is loam that is up to 20 percent shot 2 to 5 millimeters in diameter. The B horizon is brown or reddish brown when dry and dark brown, dark reddish brown, or reddish brown when moist. The C horizon is brown or reddish brown when dry and dark brown, dark reddish brown, or reddish brown when moist. It is loam to heavy loam. Depth to bedrock is 40 to 60 inches or more.

6B-Culbertson loam, 0 to 8 percent slopes. This nearly level to gently sloping soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative. mapping unit is in .the NW1/4NW1/4NW1/4, sec. 13, T. 2 N., R. 11 E. Included in mapping were areas of Oak Grove and Parkdale soils that make up about 15 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; woodland suitability group 4o1; wildlife group 2.

6C-Culbertson loam, 8 to 12 percent slopes. This moderately sloping soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representa tive mapping unit is in the NE1/4SE1/4SE1/4, sec. 11, T. 2 N., R. 11 E. Included in mapping were areas of Oak Grove and Parkdale soils that make up about 15 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; woodland suitability group 4o1; wildlife group 2.

6D-Culbertson loam, 12 to 20 percent slopes. This moderately steep soil occurs as broad, irregularly shaped areas. The soil has the profile described as representative of the series. A representative mapping unit is in the NE1/4SE1/4SE1/4, sec. 3, T. 1 N., R. 10 E. Included in mapping were areas of Oak Grove and Parkdale soils that make up about 15 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; woodland suitability group 4o1; wildlife group 2.

6E-Culbertson loam, 20 to 30 percent slopes. This steep soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4NE1/4NE1/4, sec. 11, T. 2 N., R. 10 E. Included in mapping were areas of Oak Grove and Parkdale soils that make up about 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability unit IVe-1; woodland suitability group 4o1; wildlife group 2.

6F-Culbertson loam, 30 to 50 percent slopes. This steep soil occurs as long, narrow areas. It has a profile similar to the one described as. representative of the series. A representative mapping unit is in the NW1/4SE1/4NE1/4, sec. 2, T. 2 N., R. 10 E. Included in mapping were areas of Frailey, Oak Grove, Parkdale, and Wyeth soils that make up as much as 20 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIe; woodland suitability group 4r1; wildlife group 2.

Cumulic Haplaquolls

Cumulic Haplaquolls are somewhat poorly drained and poorly drained soils along streams and in depressions on alluvial fans. They formed in alluvium of mixed origin. Slopes are 0 to 3 percent. Elevation is 100 to 2,500 feet. The vegetation is sedges, bunchgrasses, shrubs, and forbs. Average annual precipitation is 30 to 45 inches. The average annual air temperature is 45° to 52° F., and the frost-free period is 100 to 180 days.

These soils are stratified and are variable in texture. The surface layer, subsoil, and substratum are dark brown or darker silt loam, loam, sandy loam, and clay loam. Distinct mottling occurs between depths of 10 to 30 inches. Rounded pebbles or cobbles commonly form thin stone lines, or layers, below the surface layer.

Permeability, available water capacity, and water-supplying capacity are variable. Rooting depth is 60 inches or more. The soils are subject to occasional flooding. The water table is 1.5 to 3 feet below the surface.

Cumulic Haplaquolls are used for grazing and wildlife habitat.

7A-Cumulic Haplaquolls, nearly level. Mapped areas of these soils are mostly small and irregular in shape. They occur along streams. Included in mapping were small areas of Wyeast and Dee soils. Runoff is slow, and the erosion hazard is slight. The hazard of streambank erosion is high (fig. 3). Capability unit IVw-1; wildlife group 1.

Cumulic Haploxerolls

Cumulic Haploxerolls are well drained and moderately well drained soils along major streams and on alluvial fans. They formed in mixed medium textured alluvium. Slopes are 0 to 3 percent. The vegetation is trees, grasses, forbs, and shrubs. Average annual precipitation is 30 to 40 inches. The average annual air temperature is 49° to 50° F., and the frost-free period is 150 to 180 days.

These soils are stratified and are variable in texture. The surface layer is dark brown or darker to a depth of more than 20 inches. The surface layer, subsoil, and substratum are silt loam, loam, sandy loam, and clay loam.

Permeability, available water capacity, and water-supplying capacity are variable. Rooting depth is more than 60 inches. The soils are rarely flooded.

Cumulic Haploxerolls are used for hay, pasture, and wildlife habitat.

8A-Cumulic Haploxerolls, nearly level. Mapped areas of these soils are mostly small and irregular in shape. They occur along major streams, but are rarely flooded. Runoff is slow, and the erosion hazard is slight. Capability unit IIe-2; wildlife group 1.

Dee Series

The Dee series consists of somewhat poorly drained soils on terraces. These soils formed in volcanic, ash deposits. Slopes are 0 to 12 percent. Elevation is 1,000 to 2,500 feet. The vegetation is Douglas-fir, grand fir, ponderosa pine, forbs, and shrubs. Average annual precipitation is 35 to 45 inches, the average annual air temperature is 45° to 49° F., and the frost-free period is 100 to 120 days.

In a representative profile the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper 11 inches of the subsoil is brown loam. The lower 26 inches is brown loam. The substratum is dark yellowish brown sandy loam about 27 inches thick. The soil is slightly acid in the surface layer and upper part of the subsoil and medium acid in the lower part of the subsoil and in the substratum.

Permeability is moderate. Available water capacity is 15 to 17 inches. Water-supplying capacity is 18 to 20 inches. Effective rooting depth is more than 60 inches. The water table is at a depth of 2 to 3 feet.

Figure 3.-Streambank erosion on Cumulic Haplaquolls.

Dee soils are used for fruit orchards, hay, pasture, and wildlife habitat.

Representative profile of Dee silt loam, 0 to 8 percent slopes, NW1/4NE1/4SW1/4 sec. 33, T. 1 N., R. 10 E.

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (l0YR 6/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; slightly acid; clear wavy boundary.

B1-8 to 19 inches; brown (10YR 4/3) loam, light gray (10YR 7/2) dry; common fine distinct brown and grayish brown (7.5YR 4/4 and 10YR 5/2 moist) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular and tubular pores; slightly acid; clear wavy boundary.

B21-19 to 34 inches; brown (l0YR 4/3) loam, very pale brown (l0YR 7/3) dry; many fine distinct grayish brown and brown (10YR 5/2 and 7.5YR 4/4) when moist mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; about 3 percent pebbles 1 to 2 millimeters in size; slightly acid; gradual smooth boundary.

B22-34 to 45 inches; brown (l0YR 5/3) loam, very pale brown (l0YR 7/3) dry; many medium distinct brown and grayish brown (7.5YR 5/2 and 4/4) when moist mottles; weak medium subangular blocky structure; slightly hard, slightly brittle when moist, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; about 5 percent pebbles 1 to 2 millimeters in size; medium acid; gradual smooth boundary.

C-45 to 72 inches; dark yellowish brown (l0YR 4/4) sandy loam, very pale brown (l0YR 7/3) dry; many medium distinct brown (7.5YR 5/2 and 4/4) when moist mottles massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; about 10 percent pebbles 1 to 2 millimeters in size; medium acid.

The A horizon is pale brown, grayish brown, or light brownish gray when dry and dark brown, very dark grayish brown, or dark grayish brown when moist. It is silt loam or loam that is 5 to 20 percent pebbles 1 to 3 millimeters in diameter. The B horizon is light gray, very pale brown, or pale brown when dry and brown or grayish brown when moist. The C horizon is grayish brown, light yellowish brown, or very pale brown when dry and dark yellowish brown, brown, or very dark grayish brown when moist. It is loam, fine sandy clay loam, or sandy loam that is up to 35 percent cobbles and pebbles. Depth to bedrock is more than 60 inches.

9B-Dee silt loam, 0 to 8 percent slopes. This nearly level to gently sloping soil occurs as long, irregularly shaped areas. It has the profile described as representative of the series. A representative mapping unit is in the NW1/4NE1/4SW1/4 sec. 33, T. 1 N., R. 10 E. Included in mapping were small areas of moderately deep very cobbly or gravelly loams and areas of Parkdale soils, all of which make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIw-1; wildlife group 1.

9C-Dee silt loam, 8 to 12 **percent slopes.** This moderately sloping soil occurs as long, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4NE1/4NE1/4 sec. 20, T. 1 N., R. 10 E. Included in mapping were small areas of moderately deep very cobbly or gravelly loams and areas of Parkdale soils, all of which make up about 20 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; wildlife group 1.

Divers Series

The Divers series consists of well drained soils on uplands. These soils formed in mixed ash, mudflow, and colluvium weathered from basalt and andesite. Slopes are 3 to 65 percent. Elevation is 3,000 to 4,800 feet. The vegetation is western hemlock, grand fir, noble fir, white pine, forbs, and shrubs. The dominant understory plants are western fescue, mountain brome, common beargrass, western starflower, deerfoot vanillaleaf, Pacific rhododendron, big huckleberry, Cascade oregongrape, common snowberry, and vine maple. Average annual precipitation is 50 to 90 inches, average annual air temperature is 38° to 42° F., and the frost-free period is 30 to 60 days.

In a representative profile the surface layer is dark .brown gravelly loam about 4 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam. The lower 33 inches is reddish brown gravelly loam. The substratum is mostly rock fragments with reddish brown loam interstitial material. The soil is medium acid in the surface layer and lower part of the subsoil and slightly acid in the upper part of the subsoil.

Permeability is moderately rapid. Available water capacity is 7 to 10 inches. Water-supplying capacity is 14 to 20 inches. Effective rooting depth is 40 to 60 inches or more.

Divers soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Divers gravelly loam, 3 to 30 percent slopes, in SE1/4NW1/4, sec. 17, T. 1 N., R. 9 E.

O1-1 ½ inches to 0 needles, leaves, and twigs.

A1-0 to 4 inches; dark brown (7.5YR 3/4) gravelly loam, brown (7.5YR 5/4) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine irregular pores; 25 percent pebbles; medium acid; gradual smooth boundary.

Bl-4 to 13 inches; dark brown (7.5YR 3/4) gravelly loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine tubular pores; 25 percent pebbles; slightly acid; clear wavy boundary.

B21-13 to 27 inches; reddish brown (5YR 4/4) gravelly loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine tubular pores; 30 percent pebbles, 10 percent cobbles; slightly acid; gradual wavy boundary.

B22-27 to 46 inches; reddish-brown (5YR 4/4) gravelly loam, strong brown (7.5YR 5/6) dry; weak medium subangular blocky structure, slightly hard, friable, slightly sticky and slightly plastic; few roots; many very fine irregular pores; 15 percent cobbles, 30 percent pebbles; medium acid; clear wavy boundary.

IIC-46 to 60 inches; 80 percent stones, cobbles and pebbles with reddish brown (5YR 4/4) loam interstitial material; single grained; loose.

The A horizon is dark brown, dark reddish brown, or brown when moist. It is gravelly sandy loam or gravelly loam that is 20 to 25 percent pebbles. Structure is weak or moderate granular. The B horizon is gravelly loam that is

less than 18 percent clay. It is 25 to 40 percent pebbles and 10 to 20 percent cobbles. Structure is weak or moderate granular or subangular blocky. The fine earth fraction of the profile is 20 to 60 percent ash or other pyroclastic material. The content of rock fragment in the 10 to 40-inch control section ranges from 35 to 50 percent. Depth to bedrock is 40 to 60 inches or more.

10E-Divers gravelly loam, 3 to 30 percent slopes. This moderately steep soil occurs as long, broad areas. It has the profile described as representative of the series. A representative mapping unit is in the SE1/4NE1/4 sec. 17, T. 1 N., R. 9 E. Included in mapping were small areas of Hutson and Yallani soils that make up as much as 15 percent of the mapping unit.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Capability subclass VIs; woodland suitability group 4f3; wildlife group 3.

10F-Divers gravelly loam, 30 to 65 percent slopes. This very steep soil occurs as long, broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4NE1/4, sec. 18, T. 1 N., R. 9 E. Included in mapping were areas of Hutson and Yallani soils that make up as much as 20 percent' of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIs; woodland suitability group 4f4; wildlife group 3.

Frailey Series

The Frailey series consists of well drained soils on uplands. These soils formed in volcanic ash, loess, and colluvium weathered from semiconsolidated sedimentary materials. Slopes are 30 to 70 percent. Elevation is 1,000 to 3,500 feet. The vegetation is oak, ponderosa pine, Douglas-fir, bunchgrasses, forbs, and shrubs. The dominant understory plants are elk sedge, tall trisetum, lupine, tall oregongrape, creambush oceanspray, and western hazel. Average annual precipitation is 25 to 30 inches, the average annual air temperature is 45° to 49° F., and the frost-free period is 100 to 140 days.

In a representative profile the surface layer is very dark grayish brown and dark brown loam about 13 inches thick. The subsoil is dark brown loam about 23 inches thick. The substratum is dark brown loam. The soil is slightly acid.

Permeability is moderate. Available water capacity is 8 to 10 inches. Water-supplying capacity is 10 to 15 inches. Effective rooting depth is 40 to 60 inches or more.

Frailey soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Frailey loam, 30 to 70 percent slopes, in NE1/4NE1/4SW1/4, sec. 21, T. 2 N., R. 11 E.

O1-1 inch to 0; fir needles, twigs, and partially decomposed material.

A1-0 to 3 inches; very dark grayish brown (10YR 3/2) loam, brown (l0YR 5/3) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; 15 percent fine pebbles; slightly acid; clear smooth boundary. A3-3 to 13 inches; dark brown (10YR 3/3) loam, pale brown (l0YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 15 percent fine pebbles; slightly acid; clear wavy boundary.

B2-13 to 23 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 5 percent fine pebbles; slightly acid; clear wavy boundary.

B3-23 to 36 inches; dark brown (l0YR 4/3) loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; 5 percent pebbles; slightly acid; clear wavy boundary.

C-36 to 60 inches; dark brown (l0YR 4/3) heavy loam, light gray (10YR 7/2) dry; massive; hard, firm, slightly sticky and slightly plastic; few fine and medium roots; few very fine tubular pores; 5 percent pebbles; few thin clay films in pores; slightly acid.

The A horizon is brown or light brownish gray when dry and very dark grayish brown or dark brown when moist. The B horizon is loam that is 5 to 20 percent pebbles and 0 to 15 percent cobblestones. Depth to rippable bedrock is 40 to 60 inches or more.

The Frailey soils mapped in the Hood River Area are slightly finer textured in the substratum than is defined for the series, but this difference does not alter their use and management.

11F-Frailey loam, 30 to 70 percent slopes. This very steep soil occurs as long, narrow areas and has north-facing slopes. It has the profile described as representative of the series. A representative mapping unit is in the NE1/4NE1/4SW1/4 sec. 21, T. 2 N., R. 11 E. Included in mapping were areas of moderately deep, shallow, and very stony soils and areas of Culbertson and Wamic soils, all of which make up as much as 20 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIe ; woodland group 4r1; wildlife group 2.

Hood Series

The Hood series consists of well drained soils on dissected terraces. These soils formed in very deep silty lacustrine deposits. Slopes are 0 to 40 percent. Elevation is 500 to 850 feet. The vegetation is Douglas-fir, ponderosa pine, forbs, and shrubs. Average annual precipitation is 30 to 35 inches, the average annual air temperature is 49° to 51° F., and the frost-free period is 150 to 180 days.

In a representative profile the surface layer is very dark grayish brown and dark brown loam about 6 inches thick. The upper 32 inches of the subsoil is dark brown loam. The lower 35 inches is dark brown, slightly brittle loam. The substratum is dark brown loam and very fine sandy loam about 35 inches thick. The soil is medium acid and slightly acid.

Permeability is moderate. Available water capacity is 11 to 13 inches. Water-supplying capacity is 16 to 18 inches. Effective rooting depth is more than 60 inches.

Hood soils are used for fruit orchards and wildlife habitat.

Representative profile of Hood loam, 0 to 3 percent slopes, 440 feet east and 430 feet north of the south quarter corner in SW1/4SW1/4SE1/4, sec. 13, T. 2 N., R. 10 E.

Ap1-0 to 3 inches; very dark grayish brown (l0YR 3/2) loam, grayish brown (l0YR 5/2) dry; weak fine

granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; few fine 1 to 2 millimeter reddish brown and black concretions; medium acid; abrupt smooth boundary.

Ap2-3 to 6 inches; dark brown (l0YR 3/3) loam, brown (l0YR 5/3) dry; weak thick platy structure parting to weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine 1 to 2 millimeter reddish brown and black concretions; medium acid; abrupt smooth boundary.

B11-6 to 16 inches; dark brown (l0YR 4/3) loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few reddish brown and black concretions, thin coatings of clean sand grains on peds; slightly acid; gradual smooth boundary.

B12-16 to 27 inches; dark brown (l0YR 4/3) loam, pale brown (l0YR 6/3) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; thin clay films in some pores; some clean sand grains on peds; slightly acid; clear smooth boundary.

B21t-27 to 38 inches; dark brown (10YR 4/3) loam, yellowish brown (l0YR 5/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; common thin clay films on peds and in pores; common clean sand grains on peds; medium acid; clear .smooth boundary.

B22t-38 to 58 inches; dark brown (10YR 4/3) loam, yellowish brown (l0YR 5/4) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly brittle, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few thin clay films on peds and thick clay films in some pores; few black stains; few clean sand grains on peds; medium acid; clear wavy boundary.

B3t-58 to 73 inches; dark brown (10YR 4/3) loam, yellowish brown (l0YR 5/4) dry; weak coarse prismatic structure and weak medium subangular blocky; hard, firm, slightly brittle, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few thin clay films on peds and thick clay films in some pores; few black stains; few clean sand grains on faces of peds; medium acid; clear smooth boundary.

C1-73 to 98 inches; dark brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine pores; thick clay films in some pores; few 1 to 8 millimeter black stains; few clean sand grains in places on vertical fractures; medium acid; clear smooth boundary.

C2-98 to 108 inches; dark brown (10YR 4/3) very fine sandy loam, pale brown (l0YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; few roots; few very fine to medium pores; medium acid.

The A horizon is very dark grayish brown, dark brown, or dark yellowish brown when moist. It is loam or silt loam. The B horizon is brown, yellowish brown, or pale brown when dry and dark brown or dark yellowish brown when moist. It is loam or silt loam. Gray coarse silt and fine sand grains range from few to common on peds and clay films range from thin to moderately thick on peds and in pores. The C horizon is pale brown, brown, or light yellowish brown when dry and dark brown or dark yellowish brown when moist. It is stratified silt loam, loam, and very fine sandy loam. Depth to bedrock is more than 60 inches.

12A-Hood loam, 0 to 3 percent slopes. This nearly level soil occurs as broad, irregularly shaped areas on terraces. The profile is that described as representative of the series. A representative mapping unit is in the SW1/4SW1/4SE1/4 sec. 13, T. 2 N, R. 10 E. Included in mapping were areas of Wyeast soils that make up about 15 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit I-1; wildlife group 1.

12B-Hood loam, 3 to 8 percent slopes. This soil occurs as broad, irregularly shaped areas on terraces. Slopes average 5 percent. The profile is similar to the one described as representative of the series. A representative mapping unit is in the NE1/4NE1/4NE1/4 sec. 23, T. 2 N., R. 10 E. Included in mapping were areas of Van Horn and Wyeast soils that make up about 15 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; wildlife group 1.

12C-Hood loam, 8 to 12 percent slopes. This soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4NW1/4SW1/4 sec. 24, T. 2 N., R. 10 E. Included in mapping were areas of Van Horn and Wyeast soils that make up about 15 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; wildlife group 1.

12D-Hood loam, 12 to 20 percent slopes. This moderately steep soil occurs as long, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4NW1/4NE1/4, sec. 26, T. 2 N., R. 10 E. Included in mapping were areas of Van Horn soils that make up about 10 percent of the mapping unit and areas of the Van Horn and Wyeast soils that make up about 5 percent.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; wildlife group 1.

12E-Hood loam, 20 to 40 percent slopes. This steep soil occurs as long and narrow, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4SW1/4SW1/4 sec. 14, T. 2 N., R. 10 E. Included in mapping were areas of Van Horn soils that make up about 10 percent of the mapping unit and areas of Wyeast soils that make up about 5 percent.

Runoff is rapid, and the hazard of erosion is high. Capability unit IVe-1; wildlife group 1.

Hutson Series

The Hutson series consists of well drained soils on uplands. These soils formed in volcanic ash and mixed colluvium high in pyroclastic materials. Slopes are 0 to 65 percent. Elevation is 2,400 to 4,600 feet. The vegetation is Douglas-fir, grand fir, noble fir, white pine, western hemlock, vine maple, hazel, golden chinquapin, and related forbs. The dominant understory plants are western fescue, mountain brome, common beargrass, deerfoot vanillaleaf, Pacific rhododendron, big huckleberry, Cascade oregongrape, common snowberry, and vine maple. Average annual precipitation is 50 to 90 inches, the average annual air temperature is 38° to 42° F., and the frost-free period is 30 to 60 days.

In a representative profile the surface layer is dark brown fine sandy loam about 4 inches thick. The upper

14 inches of the subsoil is dark brown fine sandy loam, the middle 11 inches is yellowish red fine sandy loam, and the lower 16 inches is dark brown fine sandy loam. The substratum is reddish brown loam about 17 inches thick. The soil is slightly acid in the surface layer and subsoil and medium acid in the substratum.

Permeability is moderately rapid. Available water capacity is 11 to 14 inches. Water-supplying capacity is 14 to 20 inches. Effective rooting depth is more than 60 inches.

Hutson soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Hutson fine sandy loam, 0 to 30 percent slopes, near Lumsford gate in SE1/4SE1/4SW1/4 sec. 31, T. 1 S., R. 10 E.

O1-1 1/2 inches to 0; fir needles, twigs, moss.

A2-0 to 4 inches; dark brown (7.5YR 4/2) fine sandy loam, pinkish gay (7.5YR 6/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; many very fine irregular pores; slightly acid; clear smooth boundary.

B21-4 to 18 inches; dark brown (7.5YR 4/4) fine sandy loam, light brown (7.5YR 6/4) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; many very fine tubular pores; slightly acid; gradual smooth boundary.

B22-18 to 29 inches; yellowish red (5YR 4/6) fine sandy loam, reddish brown (5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many roots; many very fine tubular pores; slightly acid; gradual smooth boundary.

B23-29 to 45 inches; dark brown (7.5YR 4/4) fine sandy loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; common very fine tubular pores; 5 percent pebbles; medium acid; gradual smooth boundary.

IIC1-45 to 65 inches; reddish brown (5YR 4/4) loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; common very fine tubular pores; 10 percent pebbles, 5 percent cobbles; medium acid.

The A horizon is pinkish gray or light brown when dry. It is fine sandy loam or very fine sandy loam. The B horizon is fine sandy loam or loam that is 0 to 15 percent pebbles and 0 to 10 percent cobbles. The C horizon is loam or fine sandy loam that is 3 to 20 percent pebbles, 0 to 15 percent cobbles, and 0 to 15 percent stones. Depth to bedrock is more than 60 inches.

13E-Hutson fine sandy loam, 0 to 30 percent slopes. This nearly level to steep soil occurs as broad, irregularly shaped areas. It has the profile described as representative of the series. A representative mapping unit is in the SE1/4SE1/4SW1/4, sec. 31, T. 1 S., R. 10 E. Included in mapping were areas of Divers and Yallani soils that make up as much as 15 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability subclass VIe; woodland suitability group 4o2; wildlife group 3.

13F-Hutson fine sandy loam, 30 to 65 percent slopes. This very steep soil occurs as long, broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4SW1/4 section 19, T. 1 S., R. 10 E. Included in mapping were areas of Divers and Yallani soils that make up as much as 20 percent of this mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIe; woodland suitability group 4r2 ; wildlife group 3.

Ketchly Series

The Ketchly series consists of well drained soils on uplands. These soils formed in loess, volcanic ash, and colluvium weathered from andesite. Slopes are 3 to 65 percent. Elevation is 2,000 to 3,600 feet. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, bunchgrasses, forbs, and shrubs. The dominant understory plants are elk sedge, western fescue, western starflower, strawberry, low oregongrape, common snowberry, creambush oceanspray, and western hazel. Average annual precipitation is 25 to 35 inches, the average annual air temperature is 42° to 45° F., and the frost-free period is 70 to 120 days.

In a representative profile the surface layer is dark brown loam about 12 inches thick. The subsoil is dark brown and strong brown heavy loam about 33 inches thick. The substratum is dark brown clay loam to a depth of 48 inches. The soil is neutral and slightly acid.

Permeability is moderately slow. Available water capacity is 6 to 11 inches. Water-supplying capacity is 10 to 15 inches. Effective rooting depth is 40 to 60 inches.

Ketchly soil is used for woodland, water supply, and wildlife habitat.

Representative profile of Ketchly loam, 3 to 30 percent slopes, in NW1/4SW1/4NW1/4 sec. 21, T. 2 N., R. 11 E.

O1-1 inch to 0; fir needles and twigs, grass and deciduous leaves.

A11-0 to 6 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; 5 percent pebbles, 1/8 to 1/2 inch in diameter; neutral; gradual smooth boundary.

A12-6 to 12 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and medium roots; many very fine tubular pores; 5 percent pebbles, 1/8 to 1/2 inch in diameter; neutral; clear smooth boundary.

B1-12 to 16 inches; dark brown (7.5YR 3/2) heavy loam, brown (7.5YR 5/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; many fine and medium roots; many very fine tubular pores; neutral; gradual smooth boundary.

B21t-16 to 22 inches; dark brown (7.5YR 4/4) heavy loam, brown (7.5YR 5/2) dry ; weak coarse subangular blocky structure; very hard, firm, sticky and plastic; many fine roots; many very fine tubular pores; common thin clay films in pores and on peds; slightly acid; gradual smooth boundary.

B22t-22 to 45 inches; strong brown (7.5YR 5/6) heavy loam, light brown (7.5YR 6/4) dry; weak coarse subangular blocky structure; extremely hard, firm, slightly sticky and slight plastic; few fine and medium roots; many very fine tubular pores; many dark brown (7.5YR 4/4) thick clay films on peds and in pores; peds coated with clean sand grains; few black manganese stains on peds; slightly acid; gradual wavy boundary.

IIC-45 to 48 inches; dark brown (7.5YR 4/4) clay loam; massive; extremely hard, very firm, sticky and plastic; common very fine pores; 5 percent pebbles; few strong brown (7.5YR 5/6) weathered rock fragments.

The B2t horizon is loam, heavy loam, or clay loam that is 0 to 30 percent rock fragments. Depth to bedrock is 40 to 60 inches or more.

14E-Ketchly loam, 3 to 30 percent slopes. This nearly level to steep soil occurs on broad ridgetops. It has the profile described as representative of the series. A representative mapping unit is in the SE1/4NW1/4NW1/4 sec. 4, T. 1 N., R. 11 E. Included in mapping were areas of Bins, Bindle, Frailey, and Bald soils and areas of shallow stony loams, all of which make up as much as 15 percent of this mapping unit.

Runoff is slow, and the hazard of erosion is moderate. Capability subclass VIe; woodland suitability group 4o1; wildlife group 2.

14F-Ketchly loam, 30 to 65 percent slopes. This very steep soil, occurs on long narrow ridges. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4NE1/4 sec. 10, T. 1 N., R. 11 E. Included in mapping were areas of Bins, Bindle, Frailey, and Bald soils that make up as much as 15 percent of this mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIe; woodland suitability group 4r1; wildlife group 2.

Lava Flows

15-Lava flows occurs as a long, narrow area on the west side of Dee Flat. These flows are recent. A representative mapping unit is in the NE1/4NE1/4SW1/4, sec. 12, T. 1 S., R. 10 E. Capability subclass VIIIs.

Oak Grove Series

The Oak Grove series consists of well drained soils on uplands. These soils formed in deep clayey mudflows and alluvial materials. Slopes are 0 to 60 percent. Elevation is 500 to 1,800 feet. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, forbs, and shrubs. The dominant understory plants are mountain brome, blue wildrye tall oregongrape, trailing blackberry, common snowberry, deerbrush, Pacific dogwood, and western hazel. Average annual precipitation is 35 to 45 inches, the average annual air temperature is 48° to 51° F., and the frost-free period is 120 to 180 days.

In a representative profile the surface layer is dark brown loam about 13 inches thick. The upper 13 inches of the subsoil is dark brown loam, the middle 8 inches is dark reddish brown clay loam, and the lower 44 inches is dark reddish brown and reddish brown clay. Depth to bedrock is more than 60 inches. The soil is strongly acid and medium acid in the surface layer and slightly acid and medium acid in the subsoil.

Permeability is moderately slow. Available water capacity is 9 to 10 inches. Water-supplying capacity is 13 to 16 inches. Effective rooting depth is more than 60 inches.

Oak Grove soils are used for fruit orchards, pasture, woodland, wildlife habitat, and water supply.

Representative profile of Oak Grove loam, 0 to 8 percent slopes, 65 feet east and 415 feet north of the quarter corner in SW1/4SW1/4NW1/4, sec. 9, T. 2 N., R. 10 E.

Ap-0 to 7 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; few concretions 1-2 millimeters in diameter; strongly acid; clear smooth boundary.

A3-7 to 13 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few concretions 1-2 millimeters in diameter; medium acid; clear wavy boundary.

B11-13 to 26 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; common clean sand grains on peds; few concretions 1-5 millimeters in diameter; slightly acid; clear wavy boundary.

B12-26 to 34 inches; dark reddish brown (5YR 3/4) clay loam, reddish brown (5YR 5/4) dry; moderate medium and fine subangular blocky structure; hard, firm, very sticky and very plastic; common very fine roots; many very fine tubular pores; few thin c la films in pores; common clean sand grains on peds; few concretions 1-2 millimeters in diameter; medium acid; clear smooth boundary.

B21t-34 to 52 inches; dark reddish brown (5YR 3/4) clay, yellowish red (5YR 5/6) dry; moderate medium. blocky structure; very hard, very firm, very sticky and very plastic; few roots; many very fine tubular pores; few moderately thick and many thin clay films on peds and in pores; few concretions 1-2 millimeters in diameter; many large black stains; medium acid; clear wavy boundary.

B22t-52 to 66 inches; dark reddish brown (5YR 3/4) clay, yellowish red (5YR 5/6) dry; moderate medium and fine blocky structure; very hard, very firm, very sticky and very plastic; very few roots; many very fine tubular pores; few thin clay films on peds and thick clay films in pores; few concretions 1 millimeter or less in diameter; many black stains; slightly acid; clear wavy boundary.

B3-66 to 78 inches; reddish brown (5YR 4/4) clay, yellowish red (5YR 5/6) dry; moderate fine and medium blocky structure; hard, firm, very sticky and very plastic; few roots; many very fine tubular pores; few thin clay films; few black stains; medium acid.

The A horizon is brown, reddish gray, or reddish brown when dry and dark brown or dark reddish brown when moist. The B2t horizon is clay loam to clay that is more than 35 percent clay. The content of rock fragments ranges from 0 to 15 percent. Depth to bedrock is more than 60 inches.

16B-Oak Grove loam, 0 to 8 percent slopes. This nearly level to gently sloping soil occurs as broad, irregularly shaped areas. It has the profile described as representative of the series. A representative mapping unit is in the SW1/4SW1/4NW1/4 sec. 9, T. 2 N., R. 10 E. Included in mapping were areas of Culbertson and Rockford soils that make up about 5 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; woodland suitability group 4o1; wildlife group 1.

16C-Oak Grove loam, 8 to 12 percent slopes. This moderately sloping soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SE1/4SW1/4NW1/4 sec. 8, T. 2 N., R. 10 E. Included in mapping were areas of Culbertson and Rockford soils that make up about 10 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; woodland suitability group 4o1; wildlife group 1.

16D-Oak Grove loam, 12 to 20 percent slopes. This moderately steep soil occurs as irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4NW1/4SE1/4 sec. 18, T. 2 N., R. 10 E. Included in mapping were areas of Culbertson and Rockford soils that make up about 10 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; woodland suitability group 4o1; wildlife group 1.

16E-Oak Grove loam, 20 to 35 percent slopes. This steep soil occurs as narrow, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NE1/4NW1/4SE1/4 sec. 7, T. 2 N., R. 10 E. Included in mapping were areas of Culbertson and Rockford soils that make up about 10 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability unit IVe-1; woodland suitability group 4o1; wildlife group 1.

16F-Oak Grove loam, 35 to 60 percent slopes. This very steep soil occurs as narrow, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4SW1/4SW1/4 sec. 33, T. 1 N., R. 10 E. Included in mapping were areas of Culbertson and Rockford soils that make up about 15 percent of the mapping unit.

Runoff is very rapid, and the hazard of erosion is high. Capability subclass VIe; woodland suitability group 4r1; wildlife group 1.

Parkdale Series

The Parkdale series consists of well drained soils on uplands. These soils formed in deep mudflows high in pyroclastic materials. Slopes are 0 to 40 percent. Elevation is 1,000 to 2,500 feet. The vegetation is Douglas-fir, ponderosa pine, grand pine, forbs, and shrubs. The dominant understory plants are blue wildrye, tall oregongrape, trailing blackberry, common snowberry, deerbrush, Pacific dogwood, and western hazel. Average annual precipitation is 35 to 50 inches, the average annual air temperature is 45° to 49° F., and the frost-free period is 100 to 120 days.

In a representative profile the surface layer is dark brown loam about 10 inches thick. The subsoil is brown silt loam about 8 inches thick. The upper 32 inches of the substratum is brown silt loam. The lower 25 inches is yellowish brown loam. Depth to bedrock is more than 60 inches. The soil is slightly acid in the surface layer and neutral in the soil below.

Permeability is moderate. Available water capacity is 15 to 17 inches. Water-supplying capacity is 16 to 18 inches. Effective rooting depth is more than 60 inches.

Parkdale soils are used for fruit orchards, woodland, wildlife habitat, and water supply.

Representative profile of Parkdale loam, 0 to 8 percent slopes, 130 feet west and 50 feet south of the quarter corner in NE1/4NE1/4SE1/4 sec. 6, T. 1 S., R. 10 E.

Ap1-0 to 5 inches; dark brown (7.5YR 4/3) loam, brown (7.5YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; 5 percent shot 1-5 millimeters in diameter; slightly acid; clear smooth boundary.

Ap2-5 to 10 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 5 percent shot 1-5 millimeters in diameter; neutral; abrupt wavy boundary.

B2-10 to 18 inches; brown (7.5YR 4/4) silt loam, brown (7.5YR 5/4) dry; weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; common very fine or fine roots; few very fine tubular pores; 5 percent shot 1-5 millimeters in diameter; neutral; clear wavy boundary.

C1-18 to 27 inches; brown (7.5YR 4/4) silt loam, light yellowish brown (l0YR 6/4) dry massive; soft, very friable, nonsticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 5 percent shot 1-5 millimeters in diameter; neutral; clear wavy boundary.

C2-27 to 50 inches; brown (7.5YR 4/4) silt loam, light yellowish brown (l0YR 6/4) dry; massive; soft, very friable, nonsticky and slightly plastic; common very fine roots; many very fine tubular pores; common 10 percent firm nodules or shot 5-10 millimeters in diameter; neutral; clear smooth boundary.

C3-50 to 75 inches; yellowish brown (l0YR 5/4) loam, very pale brown (10YR 7/4) dry; massive; soft, friable, nonsticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; 10 percent nodules and shot 5-10 millimeters in diameter; neutral.

The A horizon is brown, dark grayish brown or grayish brown when dry and dark brown, very dark brown or very dark grayish brown when moist. It is up to 30 percent shot 1 to 5 millimeters in diameter. The C horizon below 50 inches is up to 15 percent nodules and shot 2 to 10 millimeters in diameter.

17B-Parkdale loam, 0 to 8 percent slopes. This soil occurs as broad areas on ridgetops. Slopes average 5 percent. The profile is the one described as representative of the series. A representative mapping unit is in the NE1/4NE1/4SE1/4 sec. 6, T. 1 S., R. 10 E. Included in mapping were areas of a soil that is similar to this Parkdale soil but has a gravelly or cobbly surface layer and areas of Dee soils, all of which make up less than 5 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; woodland suitability group 3o1; wildlife group 1.

17C-Parkdale loam, 8 to 12 percent slopes. This soil occurs as broad irregularly shaped areas on ridgetops. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NE1/4SW1/4SE1/4 sec. 18, T. 1 N., R. 10 E. Included in mapping were areas of a soil that is similar to this Parkdale soil but has a gravelly or cobbly surface layer and areas of Dee soils, all of which make up less than 5 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; woodland suitability group 3o1; wildlife group 1.

17D-Parkdale loam, 12 to 20 percent slopes. This moderately steep soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NE1/4SW1/4SE1/4, sec. 18, T. 1 N., R. 10 E. Included in mapping were areas of a soil that is similar to this Parkdale soil but has a gravelly or cob

bly surface layer and areas of Dee soils, all of which make up less than 5 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; woodland suitability group 3ol; wildlife group 1.

17E-Parkdale loam, 20 to 40 percent slopes. This steep soil occurs as narrow, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NE1/4NE1/4SW1/4, sec. 5, T. 1 S., R. 10 E. Included in mapping were areas of a soil that is similar to this Parkdale soil but has a gravelly or cobbly surface layer and areas of Dee soils, all of which make up less than 5 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability unit IVe-1; woodland suitability group 3o1; wildlife group 1.

Riverwash

18-Riverwash occurs as narrow, irregular strips in the bends of stream channels along the Columbia and Hood Rivers and along drainageways in the soil survey area. The strips, 2 to 10 feet above the normal waterline, are 40 to 200 yards wide and consist of sand, gravel; and well-rounded stones and boulders, chiefly of basalt. The surface generally is uneven. A representative mapping unit is in the NE1/4NW1/4SE1/4 sec. 1, T. 2 N., R. 10 E.

Riverwash supports little or no vegetation. It is subject to overflow when the water is high and is extremely droughty when the water is low. During each overflow, new deposits are received and some material is removed. Adjacent river sandbars are included in mapping.

Riverwash is used for wildlife habitat and sand and gravel. Capability subclass VIIIw; wildlife group 1.

Rock Outcrop

Rock outcrop is exposed bedrock, commonly so small and so intermingled with soil or other soil material that it is impractical to map it separately. The Rock outcrop in the Hood River Area is mostly basalt. It provides recreation areas and wildlife habitat.

19E-Rock outcrop-Bodell-Bald complex, 0 to 30 percent slopes. This mapping unit occurs only along the Columbia River in the western part of the survey area. These areas at one time were part of the Columbia River channel, but are now terraces above the river. Stream action has scoured holes in the basalt flows and deposited mixed sand and silt colluvium weathered from basalt (fig. 4) . A representative mapping unit is in the NE1/4NE1/4NE1/4 sec. 4, T. 2 N., R. 10 E.

This mapping unit is about 55 percent Rock outcrop, 20 percent Bodell soils, and 15 percent Bald soils. The profiles of the Bodell and Bald soils are similar to those described for their respective series but in some places they contain waterworn gravel and have a sandy loam surface layer. As much as 10 percent of the unit is included areas of Wind River, Culbertson, and Wamic soils.

Runoff is slow, and the hazard of erosion is slight.

This mapping unit is poor for grazing and woodland. Large areas are idle because they are not readily acces sible. Wildlife group 2; capability subclass VIIs. Bald soil in woodland suitability group 4f5; Bodell soil not assigned.

20-Rock outcrop-Rubble land complex. This mapping unit is about 65 to 75 percent Rock outcrop and 20 to 30 percent Rubble land. It is on uplands. A representative mapping unit is in the SE1/4SE1/4SW1/4 sec. 30, T. 3 N., R 11 E.

Except in the small areas of included soils, there is little or no vegetation. Elevation is 100 to 4,500 feet. Average annual precipitation is 22 to 80 inches, and the average annual air temperature is 40° to 51°. The frost-free period is 30 to 180 days.

This unit is limited by steep and very steep slopes, some of which are severely eroded. The Rock outcrop part of the unit occurs as basalt cliffs that have extremely stony and rocky foot slopes. The almost perpendicular cliffs are as much as 500 feet high. The slope range is 30 to 100 percent:

Included in mapping were small areas of Wyeth, Bindle, and Yallani soils that make up as much as 15 percent of the acreage.

This mapping unit is used mainly for wildlife habitat and water supply. Wildlife group 2 ; capability subclass VIIIs.

Rockford Series

The Rockford series consists of well drained soils on uplands. These soils formed in very stony, medium textured and moderately fine textured glacial outwash from basalt and andesite. Slopes are 0 to 30 percent. Elevation is 100 to 2,000 feet. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, forbs, and shrubs. The dominant understory plants are blue wildrye, strawberry, Himalaya blackberry, tall oregongrape, cascara, Pacific serviceberry, and western hazel. Average annual precipitation is 30 to 45 inches, the average annual air temperature is 45° to 51° F., and the frost-free period is 120 to 180 days.

In a representative profile (fig. 5) the upper 7 inches of the surface layer is dark brown stony loam. The lower 5 inches is dark reddish brown cobbly loam. The subsoil is dark reddish brown very cobbly loam about 12 inches thick. The substratum is dark brown very cobbly loam about 36 inches thick. The soil is medium acid.

Permeability is moderately slow. Available water capacity is 4 to 7 inches. Water-supplying capacity is 10 to 14 inches. Effective rooting depth is 40 to 60 inches or more.

Rockford soils are used for pasture, hay, fruit orchards, woodland, wildlife habitat, and water supply.

Representative profile of Rockford stony loam, 0 to 8 percent slopes, 1/2 mile west of Rockford in a field northwest of junction of the Country Club Road and Barrett Road in SE1/4SW1/4SE1/4, sec. 4, T. 2 N., R. 10 E.

Ap-0 to 7 inches; dark brown (7.5YR 3/2) stony loam, brown (l0YR 5/3) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; few very fine irregular pores; 10 percent stones, 10 percent cobbles, 5 percent pebbles; medium acid; clear wavy bound

A3-7 to 12 inches; dark reddish brown (5YR 3/3) cobbly

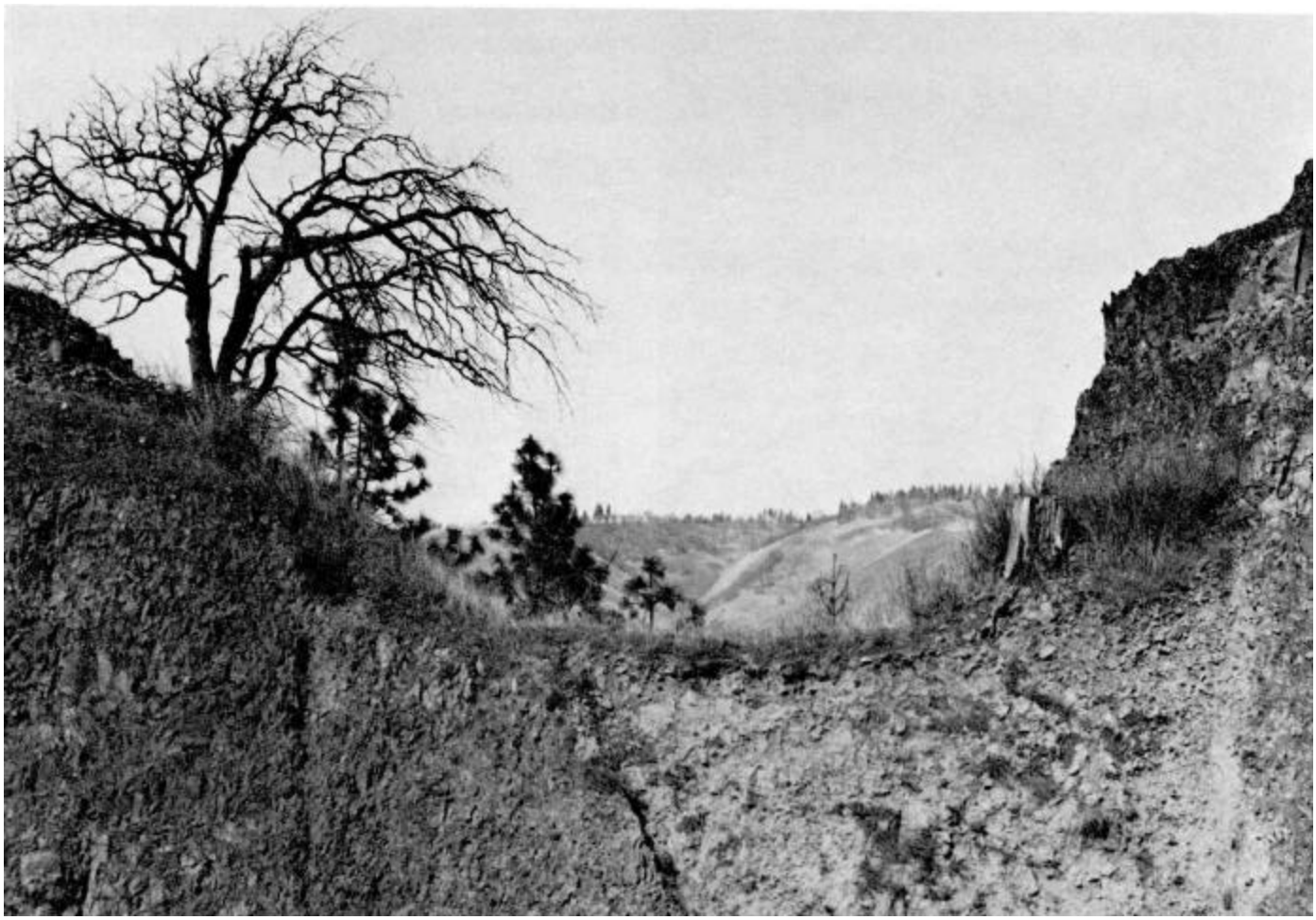

Figure 4.-Basalt outcrop and areas of Bodell soils. The deep pocket is sand and silt colluvium weathered from basalt.

loam, brown (7.5YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 10 percent stones, 15 percent cobbles, 5 percent pebbles; medium acid; diffuse smooth boundary.

B2-12 to 24 inches; dark reddish brown (5YR 3/4) very cobbly loam, brown (7.5YR 5/4) dry; moderate coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; few very fine tubular pores; 15 percent stones, 20 percent cobbles, 20 percent pebbles; medium acid; diffuse wavy boundary.

IIC-24 to 60 inches; dark brown (7.5YR 4/4) very cobbly loam, light reddish brown (5YR 6/4) dry; massive; very hard, firm, sticky and slightly plastic; few very fine roots; few very fine tubular pores; common moderately thick clay films in pores and on pebbles; 20 percent stones, 20 percent cobbles, 20 percent pebbles; medium acid.

The A horizon is grayish brown, brown, or dark grayish brown when dry and dark brown, very dark brown, or very dark grayish brown when moist. The B horizon is brown, light brown, or reddish brown when dry and dark brown or dark reddish brown when moist. It is loam or clay loam. The C horizon is light reddish brown, brown, or pale brown when dry and brown or dark brown when moist. It is clay loam, loam, or sandy loam that is 50 to more than 65 percent rock fragments. Depth to bedrock is 40 to 60 inches or more.

21B-Rockford stony loam, 0 to 8 percent slopes. This nearly level to gently sloping soil occurs as broad, irregularly shaped areas. It has the profile described as representative of the series. A representative mapping unit is in the SE1/4SW1/4SE1/4 sec. 4, T. 2 N., R. 10 E. Included in mapping were areas of Oak Grove, Wind River, and Van Horn soils that make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVs-1 irrigated, capability subclass VIs nonirrigated; woodland suitability group 3x1; wildlife group 1.

21C-Rockford stony loam, 8 to 12 percent slopes. This moderately sloping soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NW1/4NW1/4NW1/4, sec. 35, T. 2 N., R. 10 E. Included in mapping were areas of Rockford very stony loam and areas of Oak Grove, Wind River, and Van Horn soils, all of which make up about 10 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVs-1 irrigated, capability subclass VIs nonirrigated; woodland suitability group 3x1: wildlife group 1.

22E-Rockford very stony loam, 0 to 30 percent

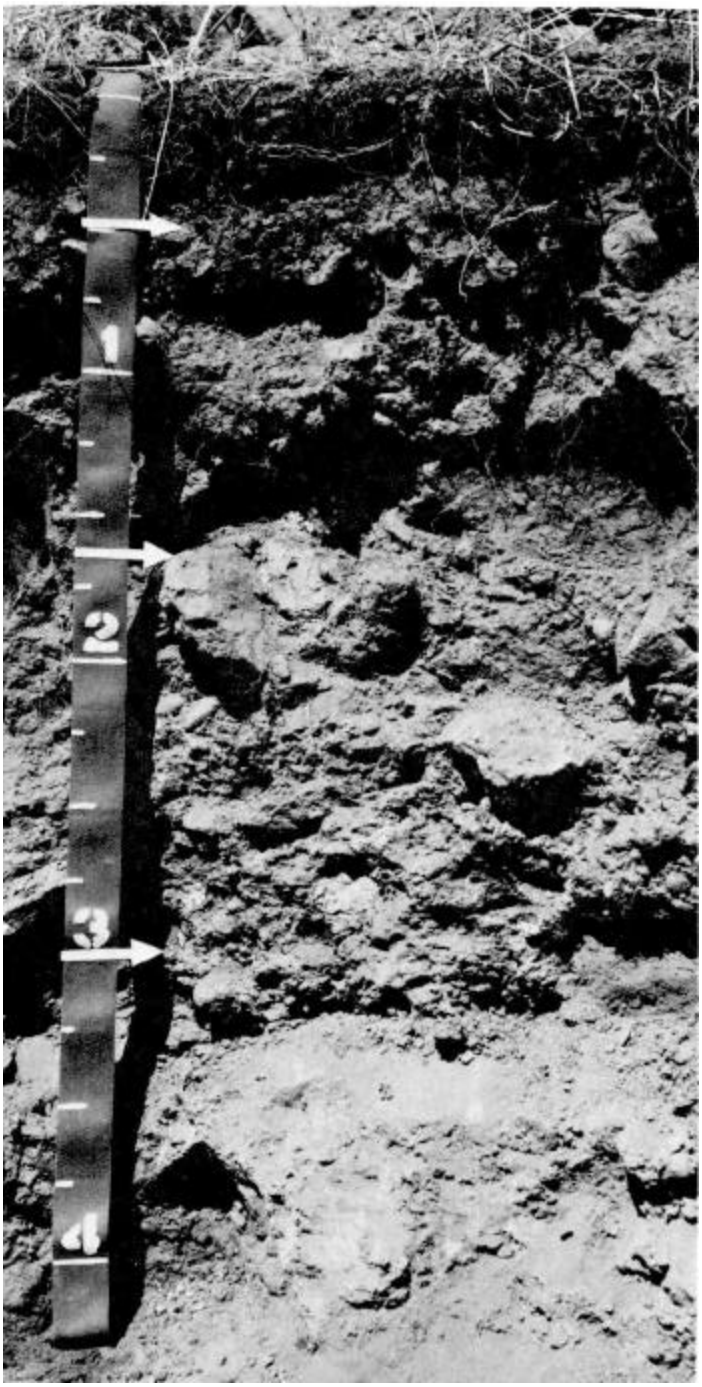

Figure 5.-Profile of Rockford stony loam, 0 to 8 percent slopes.

slopes. This nearly level to moderately steep soil occurs as narrow, irregularly shaped areas. It has a profile similar to the one described as representative of the series but the surface layer is very stony. A representative mapping unit is in the SE1/4SW1/4SE1/4 sec. 27, T. 2 N., R. 10 E. Included in mapping were areas of Rockford stony loam and areas of Oak Grove, Wind River, and Van Horn soils, all of which make up about 10 percent of the mapping unit.

Runoff, is medium, and the hazard of erosion is moderate. Capability subclass VIIs ; woodland suitability group 3x1; wildlife group 1.

Rubble Land

Rubble land is 90 percent or more stones, boulders, and talus. Practically no soil material is exposed. This land is so intermingled with basalt cliffs of Rock outcrop and with other soils that it is impractical to map it separately.

Rubble land is used for wildlife habitat.

Van Horn Series

The Van Horn series consists of well drained soils on uplands. These soils formed in stratified alluvial deposits. Slopes are 0 to 12 percent. Elevation is 100 to 850 feet. The vegetation is Douglas-fir, ponderosa pine, forbs, and shrubs. The dominant understory plants are blue wildrye, strawberry, Himalaya blackberry, tall oregongrape, cascara, arid Pacific serviceberry. Average annual precipitation is 25 to 35 inches, the average annual air temperature is 49° to 52° F., and the frost-free period is 150 to 180 days.

In a representative profile the surface layer is very dark grayish brown and dark brown fine sandy loam about 14 inches thick. The subsoil is brown and dark yellowish brown fine sandy loam and sandy clay loam about 47 inches thick. The substratum is dark brown sandy loam 11 or more inches thick. The depth to coarse textured glacial outwash or bedrock is more than 60 inches. The soil is slightly acid.

Permeability is moderate. Available water capacity is 8 to 10 inches. Water-supplying capacity is 12 to 15 inches. Effective rooting depth is more than 60 inches.

Van Horn soils are used for fruit orchards, hay, pasture, wildlife habitat, and water supply.

Representative profile of Van Horn fine sandy loam, 0 to 8 percent slopes, 1,240 feet east of southwest section corner, 100 feet north and 150 feet west of a water box in NE1/4SW1/4SW1/4 sec. 1, T. 2 N., R. 10 E.

Ap-0 to 7 inches; very dark grayish brown (l0YR 3/2) fine sandy loam, grayish brown (l0YR 5/2) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

A3-7 to 14 inches; dark brown (l0YR 3/3) fine sandy loam, brown (l0YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; slightly acid; gradual smooth boundary.

Bl-14 to 22 inches; brown (l0YR 4/3) fine sandy loam, light brownish gray (l0YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; slightly acid; gradual smooth boundary.

B21t-22 to 35 inches; dark yellowish brown (l0YR 4/4) sandy clay loam, brown (l0YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; few thin clay films on peds and common moderately thick clay films in pores; slightly acid; gradual smooth boundary:

B22t-35 to 61 inches; dark yellowish brown (l0YR 4/4) sandy clay loam, pale brown (10YR 6/3) dry; moderate medium sub angular blocky structure; hard,

friable, sticky and slightly plastic; many very fine roots; many very fine tubular pores; few thin clay films on peds and common thick clay films in pores; few black stains on peds; thin gray coatings of sand grains on peds and in pores; slightly acid; gradual smooth boundary.

C-61 to 72 inches; dark brown (l0YR 4/3) sandy loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; slightly acid.

The A horizon is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is very fine sandy loam, fine sandy loam, or loam. The B2t horizon is light brownish gray, pale brown, brown, or yellowish brown when dry and dark brown, dark yellowish brown, or dark grayish brown when moist. It is sandy clay loam, or clay loam that is 22 to 35 percent clay.

23B-Van Horn fine sandy loam, 0 to 8 percent slopes. This gently sloping soil occurs as broad irregularly shaped areas. It has the profile described as representative of the series. A representative mapping unit is in the NE1/4SW1/4SW1/4 sec. 1, T. 2 N., R. 10 E. Included in mapping were areas of Hood, Rockford, and Wind River soils that make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; wildlife group 1.

23C-Van Horn fine sandy loam, 8 to 12 percent slopes. This moderately sloping soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4SE1/4SW1/4 sec. 1, T. 2 N., R. 10 E. Included in mapping were areas where slopes are 12 to 20 percent and areas of Hood, Rockford, and Wind River soils, all of which make up about 20 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; wildlife group 1.

Van Horn Variant

The Van Horn variant consists of somewhat poorly drained soils on uplands. These soils formed in alluvial deposits. Slopes are 0 to 8 percent. Elevation is 100 to 850 feet. The vegetation is Douglas-fir, ponderosa pine, forbs, and shrubs. Average annual precipitation is 30 to 35 inches, the average annual air temperature is 49° to 52° F., and the frost-free period is 150 to 180 days.

In a representative profile the surface layer is very dark grayish brown loam about 15 inches thick. The subsoil is dark brown and dark grayish brown gravelly loam about 28 inches thick. The substratum is dark grayish brown very cobbly loam about 17 or more inches thick. Depth to very cobbly material is 40 to 60 inches or more. The soil is medium acid in the surface layer and slightly acid in the subsoil and substratum.

Permeability is moderate. Available water capacity is 6 to 9 inches. Effective rooting depth is 40 to 60 inches or more. The water table is at a depth of 3 to 4 feet.

The Van Horn variant is used for fruit orchards, hay, pasture, wildlife habitat, and water supply.

Representative profile of Van Horn variant loam, 0 to 8 percent slopes, in SE1/4NE1/4SW1/q, sec. 3, T. 2 N., R. 10 E.

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine to medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent pebbles; medium acid; clear smooth boundary.

A3-6 to 15 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (l0YR 5/2) dry; few fine yellowish red (5YR 4/6) moist mottles; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 15 percent pebbles; slightly acid; gradual smooth boundary.

B21-15 to 28 inches; dark brown (l0YR 4/3) gravelly loam, light brownish gray (l0YR 6/2) dry; common fine yellowish red (5YR 4/6) and dark grayish brown (l0YR 4/2) moist mottles; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 25 percent pebbles; few black manganese and iron concretions and stains; slightly acid; gradual smooth boundary.

B22-28 to 43 inches; dark grayish brown (10YR 4/2) gravelly loam, light brownish gray (l0YR 6/2) dry; many medium dark brown (7.5YR 4/4) moist mottles; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 20 percent pebbles and 10 percent cobbles; slightly acid; gradual smooth boundary.

C-43 to 60 inches; dark grayish brown (l0YR 4/2) very cobbly loam, light brownish gray (l0YR 6/2) dry; many medium dark brown (7.5YR 4/4) moist mottles; massive; common very fine roots; common very fine tubular pores; 10 percent gravel, 50 percent cobbles, 5 percent stones; slightly acid.

The A horizon is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. The B horizon is light brownish gray or pale brown when dry. The C horizon is light brownish gray or pale brown when dry and dark grayish brown or brown when moist. It is very cobbly loam to very cobbly sandy clay loam that is 50 to 60 percent cobbles, 2 to 15 percent stones, and 5 to 15 percent pebbles.

24B-Van Horn variant loam, 0 to 8 percent slopes. This soil occurs as narrow, irregularly shaped areas. It has the profile described as representative of the variant. A representative mapping unit is in the SE1/4NE1/4SW1/4 sec. 3, T. 2 N., R. 10 E. Included in mapping were areas of Rockford and Wind River soils that make up about 5 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIw-1; wildlife group 1.

Wamic Variant

The Wamic variant consists of well drained soils on uplands. These soils formed in mixed loess and volcanic ash deposited on moderately fine textured colluvium. Slopes are 5 to 40 percent. Elevation is 1,000 to 2,000 feet. The vegetation is ponderosa pine, Douglas-fir, Oregon white oak, shrubs, and forbs. The dominant understory plants are Idaho fescue, elk sedge, arrowleaf balsamroot, and antelope bitterbrush. Average annual precipitation is 25 to 35 inches, the average annual air temperature is 46° to 51° F., and the frost-free period is 100 to 140 days.

In a representative profile the surface layer is dark brown loam about 10 inches thick. The subsoil is dark brown loam and clay loam about 19 inches thick. The substratum is dark brown clay loam 16 or more inches thick. Basalt is at a depth of 45 inches. The soil is neutral.

Permeability is moderately slow. Available water

capacity is 6 to 10 inches. Water-supplying capacity is 8 to 12.5 inches. Effective rooting depth is 40 to 60 inches or more.

The Wamic variant is used for pasture, woodland, and wildlife habitat.

Representative profile of Wamic variant loam, 5 to 12 percent slopes, in SE1/4SW1/4SW1/4 sec. 4, T. 2 N., R. 11 E.

A1-0 to 3 inches; dark brown (7.5YR 3/2) loam, yellowish brown (l0YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

A3-3 to 10 inches; dark brown (7.5YR 3/3) heavy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many .very fine tubular pores; neutral; clear wavy boundary.

B21-10 to 17 inches; dark brown (7.5YR 3/3) heavy loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky, and slightly plastic; common very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B22-17 to 29 inches; dark brown (7.5YR 3/3) clay loam, brown (7.5YR 5/4) dry; weak fine prismatic structure parting to moderate medium subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few gray silt and sand grains on some peds; neutral; abrupt wavy boundary.

IIB2t-29 to 45 inches; dark brown (7.5YR 3/3) clay loam, brown (7.5YR 5/4) dry; massive; extremely hard, firm, sticky and plastic; many thick clay films in pores; very few fine roots; many very fine and few fine tubular pores; 3 percent coarse fragments 2 millimeters to 3 inches in size; few black manganese stains; clear wavy boundary.

IIIR-45 inches; basalt.

The A horizon is very dark grayish brown or very dark brown when moist and grayish brown or brown when dry. It has weak granular platy or subangular blocky structure. The B horizon is dark brown or dark yellowish brown when moist and yellowish brown, brown, or grayish brown when dry. It is loam or clay loam that is 20 to 27 percent clay and more than 15 percent particles coarser than very fine sand. The substratum is dark brown or dark grayish brown when moist and brown or yellowish brown when dry. It is sandy clay loam or clay loam that is 20 to 35 percent clay. The amount of ash in the profile ranges from 20 to 50 percent. Depth to bedrock is 40 to 60 inches or more.

25C-Wamic variant loam, 5 to 12 percent slopes. This soil occurs as broad, smooth areas on ridgetops and has south-facing slopes. It has the profile described as representative of the variant. Included in mapping were areas of Bald, Bodell, Frailey, and Ketchly soils that make up about 15 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-2; wildlife group 2.

25D-Wamic variant loam, 12 to 20 percent slopes. This soil occurs as irregularly shaped areas. It has a profile similar to the one described as representative of the variant. Included in mapping were areas of Bald, Frailey, and Ketchly soils that make up about 15 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-2; woodland suitability group 5o1; wildlife group 2.

25E-Wamic variant loam, 20 to 40 percent slopes. This soil occurs as long, broad and narrow irregularly shaped areas. It has a profile similar to the one described as representative of the variant. Included in mapping were areas of Bald, Frailey, and Ketchly soils that make up about 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIe; woodland suitability group 5o1; wildlife group 2.

Wind River Series

The Wind River series consists of well drained soils on uplands and terraces. These soils formed in moderately coarse textured sediments. Slopes are 0 to 12 percent. Elevation is 200 to 800 feet. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, forbs, and shrubs. The dominant understory plants are blue wildrye, strawberry, Himalaya blackberry, tall oregongrape, cascara, and Pacific serviceberry. Average annual precipitation is 30 to 35 inches, the average annual air temperature is 49° to 52° F., and the frost-free period is 150 to 180 days.

In a representative profile the surface layer is dark brown fine sandy loam about 6 inches thick. The subsoil is dark brown fine sandy loam about 10 inches thick. The upper 23 inches of the substratum is dark yellowish brown fine sandy loam. The lower 21 inches is dark yellowish brown loamy fine sand. Depth to bedrock is more than 60 inches. The soil is slightly acid.

Permeability is moderately rapid. Available water capacity is 7 to 8 inches. Water-supplying capacity is 10 to 14 inches. Effective rooting depth is more than 60 inches.

Wind River soils are used for fruit orchards, pasture, and wildlife habitat.

Representative profile of Wind River fine sandy loam, 0 to 8 percent slopes, 1,860 feet east and 960 feet north of the section corner in NW1/4SE1/4SW1/4 sec. 36, T. 3 N., R.10 E.

Ap-0 to 6 inches; dark brown (7.5YR 3/2) fine sandy loam, brown (10YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

B2-6 to 16 inches; dark brown (7.5YR 3/3) fine sandy loam, brown (l0YR 4/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular and tubular pores; slightly acid; gradual smooth boundary.

C1-16 to 27 inches; dark yellowish brown (10YR 3/4) fine sandy loam, brown (7.5YR 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; slightly acid; gradual smooth boundary.

C2-27 to 39 inches; dark yellowish brown (l0YR 3/4) fine sandy loam, brown (7.5YR 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; slightly acid; gradual smooth boundary.

C3-39 to 60 inches; dark yellowish brown (l0YR 3/4) loamy fine sand, yellowish brown (10YR 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; slightly acid.

The A horizon is brown, grayish brown, or dark grayish brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. The B horizon is brown, grayish brown, or dark grayish brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. It is fine sandy loam, loam, or sandy loam. It has weak coarse prismatic to weak coarse subangular blocky structure. The C horizon is yellowish brown, brown, or light

yellowish brown when dry and dark yellowish brown or brown when moist. It is fine sandy loam, sandy loam, loamy fine sand, or sand that is 0 to 20 percent rock fragments 2 millimeters to 5 millimeters in diameter.

26B-Wind River fine sandy loam, 0 to 8 percent slopes. This soil occurs as broad, irregularly shaped areas on ridgetops. It has the profile described as representative of the series. A representative mapping unit is in the NW1/4SE1/4SW1/4 sec. 36, T. 3 N., R. 10 E. Included in mapping were areas of Rockford, Van Horn, and Wind River variant soils that make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-1; wildlife group 1.

26C-Wind River fine sandy loam, 8 to 12 percent slopes. This soil occurs as broad, irregularly shaped areas on ridgetops. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4NW1/4NE1/4 sec. 2, T. 2 S., R. 10 E. Included in mapping were areas of Rockford, Van Horn, and Wind River variant soils that make up about 10 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-3; wildlife group 1.

Wind River Variant

The Wind River variant consists of well drained soils on uplands and terraces. These soils formed in moderately coarse textured sediments. Slopes are 0 to 30 percent. Elevation is 200 to 800 feet. The vegetation is Douglas-fir, ponderosa pine, Oregon white oak, forbs, and shrubs. Average annual precipitation is 30 to 35 inches, the average annual air temperature is 49° to 52° F., and the frost-free period is 150 to 180 days.

In a representative profile (fig. 6) the surface layer and the next layer are dark brown gravelly sandy loam about 19 inches thick. The upper 9 inches of the substratum is dark brown gravelly sandy loam.. The lower 32 inches is dark brown very gravelly sand. The depth to bedrock is more than 60 inches. The soil is slightly acid in the surface layer and the next layer and neutral in the substratum.

Permeability is moderately rapid. Available water capacity is 3 to 5 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is more than 60 inches.

The Wind River variant is used for fruit orchards, pasture, and wildlife habitat.

Representative profile of Wind River variant gravelly sandy loam, 0 to 8 percent slopes, in SW1/4SW1/4 SW1/4 sec. 35, T. 1 N., R. 10 E.

A1-0 to 9 inches; dark brown (l0YR 3/3) gravelly sandy loam, brown (l0YR 4/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots; many very fine irregular pores; 25 percent pebbles 2 millimeters to 5 millimeters in size; slightly acid; clear smooth boundary.

AC-9 to 19 inches; dark brown (7.5YR 3/3) gravelly sandy loam, brown (7.5YR 4/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine tubular pores; 25 percent pebbles 2 millimeters to 5 millimeters in size; slightly acid; clear wavy boundary.

C1-19 to 28 inches; dark brown (7.5YR 3/4) gravelly sandy loam, brown (7.5YR 5/4) dry; massive; soft, friable, nonsticky and nonplastic; many very tine roots; many very fine tubular pores; 25 percent pebbles 2 millimeters to 5 millimeters in size; neutral; abrupt wavy boundary.

IIC2-28 to 60 inches; dark brown (10YR 3/3) very gravelly sand, grayish brown (l0YR 5/2) dry; massive; loose, very friable, nonsticky and nonplastic; few medium and fine roots; few very fine tubular pores; 65 percent pebbles 2 millimeters to 5 millimeters in size; neutral.

The A and AC horizons are brown, grayish brown, or dark grayish brown when dry and very dark grayish brown, very

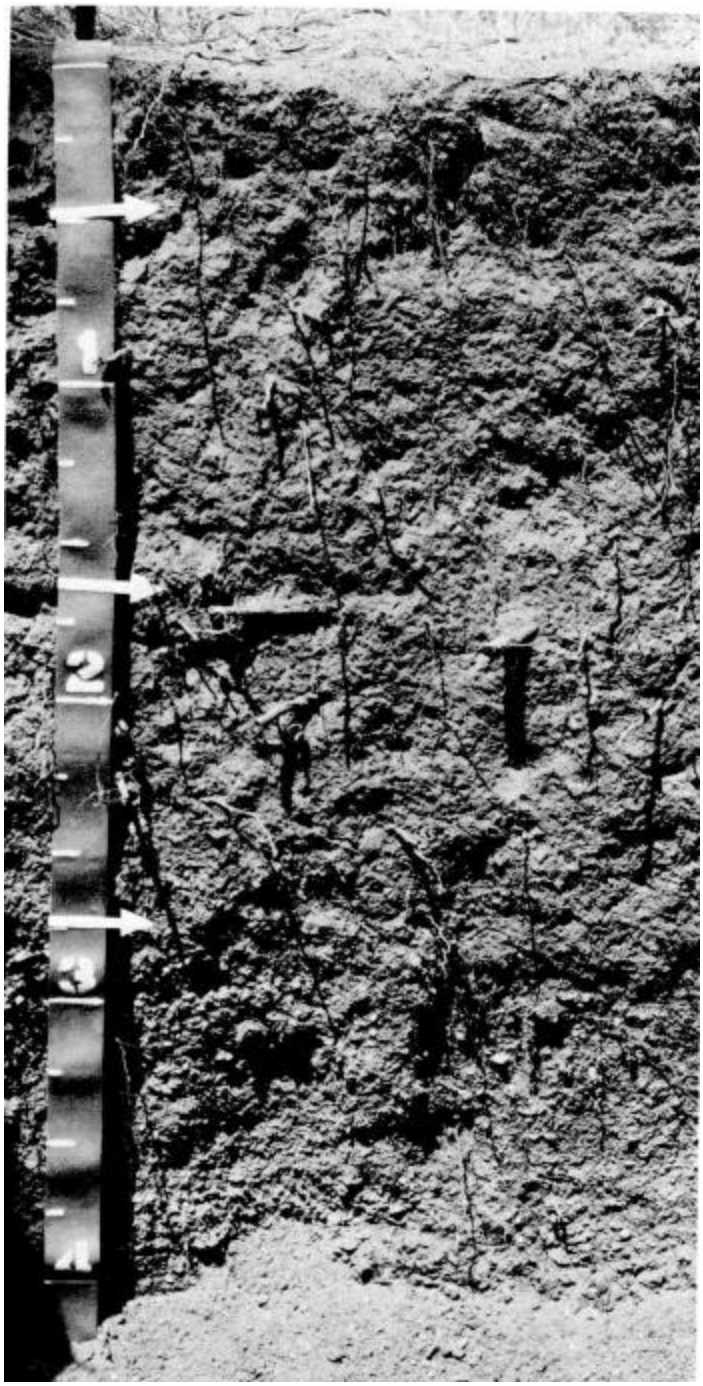

Figure 6.-Profile of Wind River variant gravelly sandy loam. Gravelly sand is at a depth of 32 inches.

dark brown, or dark brown when moist. They are mostly gravelly sandy loam that is 15 to 30 percent gravel 2 millimeters to 5 millimeters in size. The C1 horizon is brown, grayish brown, or dark grayish brown when dry and very dark grayish brown; very dark brown, or dark brown when moist. It is gravelly sandy loam or gravelly fine sandy loam that is 20 to 40 percent gravel 2 millimeters to 5 millimeters in size. The IIC2 horizon is grayish brown, yellowish brown, or brown when dry and dark yellowish brown, dark brown, or very dark grayish brown when moist. It is very gravelly loamy sand to very gravelly sand that is 55 to 80 percent gravel 2 millimeters to 5 millimeters in size.

27B-Wind River variant gravelly sandy loam, 0 to 8 percent slopes. This soil occurs as irregularly shaped areas on ridgetops. It has the profile described as representative of the variant. A representative mapping unit is in the SW1/4SW1/4SW1/4 sec. 35, T. 1 N., R.10 E. Included in mapping were areas of Rockford, Van Horn, and Wind River soils that make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-1; wildlife group 1.

27E-Wind River variant gravelly, sandy loam, 8 to 30 percent slopes. This soil occurs as irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NE1/4NW1/4NW1/4, sec. 2, T. 2 N., R. 10 E. Included in mapping were areas of Rockford, Van Horn, and Wind River soils that make up 10 percent of the mapping unit.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Capability unit IVe-3 ; wildlife group 1.

Wyeast Series

The Wyeast series consists of somewhat poorly drained soils on uplands. These soils formed in deep silty lacustrine deposits. Slopes are 0 to 12 percent. Elevation is 500 to 800 feet. The vegetation is Douglas-fir, willow, alders, forbs, and shrubs. Average annual precipitation is 30 to 35 inches, the average annual air temperature is 49° to 51° F., and the frost-free period is 150 to 180 days.

In a representative profile the upper 5 inches of the surface layer is very dark grayish brown silt loam. The lower 4 inches is dark brown silt loam. The upper 19 inches of the subsoil is dark brown silt loam. The lower 11 inches is dark brown heavy silt loam. The substratum is dark brown silt loam about 13 inches thick. Depth to the fragipan is 20 to 36 inches, and depth to bedrock or coarse textured glacial outwash is more than 60 inches. The soil is mostly slightly acid. The lower part of the subsoil is medium acid.

Permeability is moderate to the fragipan and slow in the fragipan. Available water capacity is 8 to 11 inches. Effective rooting depth is 28 to 45 inches. The water table is at a depth of 1 to 2 feet.

Wyeast soils are used for fruit orchards, hay, pasture (fig. 7), and wildlife habitat.

Representative profile of Wyeast silt loam, 0 to 8 percent slopes, in NE1/4NE1/4NW1/4, sec. 22, T. 2 N., R. 10 E.

Ap1-0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; few 1 to 2 millimeter concretions; slightly acid; abrupt smooth boundary.

Ap2-5 to 9 inches; dark brown (l0YR 3/3) silt loam, light brownish gray (l0YR 6/2) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine and fine tubular pores; few 1 to 2 millimeter concretions; slightly acid; abrupt wavy boundary.

B21-9 to 16 inches; dark brown (l0YR 4/3) silt loam, pale brown (10YR 6/3) dry; common, dark grayish brown (l0YR 4/2) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few 1 to 2 millimeter concretions; slightly acid; clear smooth boundary.

B22-16 to 28 inches; dark brown (l0YR 4/3) silt loam, light gray (10YR 7/2) dry; thin grayish brown (l0YR 5/2) coatings on peds; many fine strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, slightly brittle, slightly sticky and slightly plastic; common fine roots; many very fine and few fine tubular pores; common black stains; slightly acid; abrupt smooth boundary.

IIBx-28 to 39 inches dark brown (l0YR 4/3) heavy silt loam, light yellowish brown (10YR 6/4) dry; light brownish gray (l0YR 6/2) coatings on peds; many fine dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; hard, very firm, brittle, slightly sticky and slightly plastic; many very fine and fine tubular pores; thick clay films in pores; many black stains; medium acid; abrupt smooth boundary.

IICx-39 to 52 inches; dark brown (l0YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; light brownish gray (l0YR 6/2) coatings on peds; weak very coarse prismatic structure; hard, firm, brittle, slightly sticky and slightly plastic; many very fine and fine tubular pores; thick clay films in pores; few manganese stains; slightly acid.

The A horizon is grayish brown, brown, or pale brown when dry and very dark grayish brown or dark brown when moist. It has weak fine granular, weak coarse prismatic, or weak medium subangular blocky structure. The B horizon is pale brown, light gray, or light yellowish brown when dry and brown, dark brown, or grayish brown when moist. It is silt loam or heavy silt loam. The structure is coarse prismatic or moderate thick platy.

28B-Wyeast silt loam, 0 to 8 percent slopes. This soil occurs as broad, irregular concave areas. It has the profile described as representative of the series. A representative mapping unit is in the NE1/4NE1/4NW1/4 sec. 22, T. 2 N., R. 10 E. Included in mapping were small areas of Hood soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIw-1; wildlife group 1.

28C-Wyeast silt loam, 8 to 12 percent slopes. This moderately sloping soil occurs as broad, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the NE1/4SW1/4NE1/4, sec 22, T. 2 N., R. 10 E. Included in mapping were areas of Hood soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIw-1; wildlife group 1.

Wyeth Series

The Wyeth series consists of well drained soils on uplands. These soils formed in loess, volcanic ash, and colluvium weathered from basalt. Slopes are 5 to 75 percent. Elevation is 200 to 2,500 feet. The vegetation

Figure 7.-Irrigated pasture on Wyeast silt loam, 0 to 8 percent slopes.

is Douglas-fir, bigleaf maple, forbs, and shrubs. The dominant understory plants are thimbleberry, Cascade oregongrape, shinyleaf spirea, common snowberry, creambush oceanspray, California hazel, and vine maple. Average annual precipitation is 35 to 50 inches. The average annual air temperature is 48° to 51° F., and the frost-free period is 100 to 180 days.

In a representative profile the surface layer is black and very dark grayish brown very gravelly loam about 22 inches thick. The subsoil is dark brown very gravelly loam about 18 inches thick. The substratum is brown very gravelly loam about 22 inches thick. The soil is neutral in the surface layer and slightly acid in the subsoil and substratum.

Permeability is moderate. Available water capacity is 4 to 8 inches. Water-supplying capacity is 16 to 20 inches. Effective rooting depth is 40 to 60 inches.

Wyeth soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Wyeth very gravelly loam, 45 to 75 percent slopes, in NE1/4SE1/4SE1/4 sec. 34, T. 3 N., R. 8 E.

O1-1 inch to 0; needles, twigs, and leaves.

A11-0 to 5 inches: black (l0YR 2/1) very gravelly loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots, many very fine irregular pores; 50 percent pebbles, 5 percent cobbles; neutral; clear wavy boundary.

A12-5 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine tubular pores 50 percent pebbles, 5 percent cobbles; neutral; clear wavy boundary.

A13-10 to 22 inches; dark grayish brown (l0YR 3/2) very gravelly loam, grayish brown (l0YR 5/2) dry; weak very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium fine and very fine roots; many very fine tubular pores; 50 percent pebbles, 5 percent cobbles; slightly acid; clear wavy boundary.

B2-22 to 40 inches dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium fine and very fine roots; common very fine tubular pores; 60 percent pebbles, 15 percent cobbles; slightly acid; gradual wavy boundary.

C-40 to 62 inches; brown (l0YR 4/3) very gravelly loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; common very fine tubular pores; 10 percent pebbles, 15 percent cobbles, 5 percent stones; slightly acid.

The A horizon is black, dark brown, or very dark grayish brown when moist. It is 35 to 60 percent rock fragments. The B horizon is dark brown or brown when moist. It is loam or heavy loam and is 15 to 60 percent pebbles, 15 to 50 per

cent cobbles, and 0 to 5 percent stones. The structure is weak to moderate fine or medium subangular blocky. Depth to bedrock is 40 to 60 inches or more.

29E-Wyeth very gravelly loam, 5 to 45 percent slopes. This soil occurs as irregularly shaped areas and has north-facing slopes. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SE1/4SW1/4SW1/4 sec. 32, T. 3 N., R. 11 E. Included in mapping were areas of Bald, Bodell, and Bindle soils that make up about 15 percent of the mapping unit.

Runoff is slow to rapid, and the hazard of erosion is slight to high. Capability subclass VIs; woodland suitability group 4f1; wildlife group 2.

29F-Wyeth very gravelly loam, 45 to 75 percent slopes. This soil occurs as long areas and has north-facing slopes. It has the profile described as representative of the series. A representative mapping unit is in the NE1/4NE1/4SE1/4 sec. 31, T. 3 N., R. 11 E. Included in mapping were areas of Bald, Bodell, and Bindle soils that make up about 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIs; woodland suitability group 4f2; wildlife group 2.

Xerofluvents

Xerofluvents are well drained to moderately well drained soils dissected by numerous small drainage channels. They formed in recently deposited alluvium from ashy and sandy outwash containing a large number of basalt cobbles and pebbles. Slopes are 0 to 3 percent. The surface is convex. The vegetation is trees and grasses, forbs, and shrubs. Average annual precipitation is 30 to 60 inches. The average annual air temperature is 42° to 52° F., and the frost-free period is 30 to 180 days.

These soils are stratified and are variable in texture. The surface layer, subsoil, and substratum are very cobbly sand, cobbly loamy sand, gravelly loamy sand, loamy sand, or sand.

Permeability is dominantly rapid, and available water capacity is low. These soils are occasionally flooded. They contain appreciable amounts of organic matter, which decreases irregularly with increasing depth. The content of coarse fragments is commonly high throughout the soil, but varies. Rooting depth is 60 inches or more.

Xerofluvents are used for grazing and wildlife habitat.

30A-Xerofluvents, nearly level. Mapped areas of these soils vary in size. A representative mapping unit is in the NW1/4SE1/4 sec. 33, T. 1 N., R. 10 E.

Xerofluvents, nearly level, are used for grazing, and provide wildlife habitat. Runoff is slow, and the erosion hazard is slight. Forage yields are low. Capability subclass VIIs; wildlife group 1.

Xerumbrepts

Xerumbrepts are well drained soils on north- and south-facing canyon slopes and ridges in the uplands. They formed in colluvium of variable origin. Slopes range from 40 to 70 percent. The vegetation is mostly bunchgrasses, forbs, shrubs, and trees. Elevation is 100 to 3,600 feet. Average annual precipitation is 30 to 60 inches. The average annual temperature is 42° to 51° F., and the frost-free period is 30 to 180 days.

The surface layer and subsoil are loam, silt loam, and clay loam that usually contain varying numbers of stones, boulders, cobbles, or pebbles, or combinations of these coarse fragments. The depth to rippable bedrock is 20 to 40 inches. Rock commonly crops out.

Xerumbrepts are associated with Hood, Parkdale, Van Horn, and Wind River soils. They are used for woodland, water supply, and wildlife habitat.

31F-Xerumbrepts, very steep. This mapping unit occurs as long narrow areas about 200 to 400 acres in size. It is not extensive. A representative unit is in the SW1/4SW1/4SW1/4 sec. 13, T. 2 N., R. 10 E. Runoff is rapid, and the erosion hazard is high. Capability subclass VIIe; woodland suitability group 4r1; wildlife group 2.

Yallani Series

The Yallani series consists of well drained soils on uplands. These soils formed in volcanic ash and stony colluvium weathered from andesite and basalt. Slopes are 8 to 65 percent. Elevation is 1,800 to 3,000 feet on south-facing slopes and 1,500 to 2,400 on north-facing slopes. Vegetation is Douglas-fir, grand fir, western hemlock, bigleaf maple, forbs, and shrubs. The dominant understory plants are western fescue, mountain brome, thimbleberry, trailing blackberry, Cascade oregongrape, western hazel, vine maple, and Pacific serviceberry. Average annual precipitation is 40 to 60 inches, the average annual air temperature is 42° to 45° F., and the frost-free period is 30 to 60 days.

In a representative profile the surface layer is dark brown stony loam about 4 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam. The lower 26 inches is dark reddish brown and dark brown very gravelly loam. The substratum is dark brown very gravelly loam about 21 inches thick. The soil is mostly medium acid. The subsoil is slightly acid.

Permeability is moderately rapid. Available water capacity is 3 to 7 inches. Water-supplying capacity is 13 to 17 inches. Effective rooting depth is more than 60 inches.

Yallani soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Yallani stony loam, 30 to 65 percent slopes, 20 feet north of a logging road in SE1/4SE1/4NW1/4 sec. 21, T. 1 N., R. 9 E.

A1-0 to 4 inches; dark brown (7.5YR 3/2) stony loam, dark brown (7.5YR 4/4) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; 30 percent pebbles, 5 percent cobbles; about 0.1 percent of surface covered with stones; medium acid; clear wavy boundary.

B1-4 to 13 inches; dark brown (7.5YR 3/4) gravelly loam, dark brown (7.5YR 4/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 30 percent pebbles, 5 percent cobbles; slightly acid; gradual smooth boundary.

B21-13 to 28 inches; dark reddish brown (5YR 3/4) very gravelly loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common

very fine roots; many very fine tubular pores; 20 percent cobbles, 40 percent pebbles, 5 percent stones; slightly acid; gradual smooth boundary.

B22-28 to 39 inches; dark brown (7.5YR 3/4) very gravelly loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 40 percent pebbles, 20 percent cobbles, 5 percent stones; slightly acid; gradual smooth boundary.

C1-39 to 60 inches; dark brown (7.5YR 4/4) very gravelly loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; 30 percent cobbles, 40 percent pebbles, 5 percent stones; medium acid.

The A horizon is dark brown, dark grayish brown, or brown when dry and dark brown or very dark grayish brown when moist. It commonly is stony, cobbly, or gravelly loam that is 20 to 35 percent rock fragments. The B horizon is brown, dark yellowish brown, or yellowish brown when dry and dark brown, dark reddish brown, or dark yellowish brown when moist. It is gravelly or cobbly loam that is 35 to 65 percent rock fragments. The soil is 20 to 60 percent volcanic ash in the fine earth fraction.

32E-Yallani stony loam, 8 to 30 percent slopes.

This soil occurs as broad, long, irregularly shaped areas. It has a profile similar to the one described as representative of the series. A representative mapping unit is in the SW1/4SW1/4SE1/4 sec. 22, T. 1 N., R. 9 E. Included in mapping were areas of Bins, Divers, Hutson, Parkdale, and Bald soils that make up as much as 15 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate to high. Capability subclass VIs; woodland suitability group 3f1; wildlife group 3.

32F-Yallani stony loam, 30 to 65 percent slopes.

This soil occurs as broad, irregularly shaped areas. It has the profile described as representative of the series. A representative mapping unit is in the SE1/4SE1/4 NW1/4 sec. 21, T. 1 N., R. 9 E. Included in mapping were areas of Bins, Divers, Hutson, Parkdale, and Bald soils and areas of Rock outcrop and Rubble land, all of which make up as much as 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIIs; woodland suitability group 3f2; wildlife group 3.

Use and Management of Soils

Irrigated apple and pear orchards are the major crops in the Hood River County Area. They cover 18,000 acres, or 63 percent of the cropland. Few dryland crops are grown, other than the upland acreage of pasture and hay. Nearly all of the 9,000 acres of hay and pasture is irrigated.

Strawberries are occasionally interplanted in young orchards (fig. 8). Small acreages are planted to row crops, such as corn for silage, and to some specialty crops, such as mint and truck crops.

This part of the survey describes suitable crop management. It explains the capability grouping used by the Soil Conservation Service and suggests management suitable for the soils of each capability unit. Table 2 lists predicted average acre yields of the principal crops under high level management.

JOHN DENISON, conservation agronomist, BEN MOUCHETT and JAMES CRANE, district conservationists, Soil Conservation Service, and W. M. MELLENTHIN, pomologist, Oregon Agricultural Experiment Station, helped prepare this section.

Crops

Different soils require different management, and the same soil may require variation in management from year to year and from crop to crop. Basic management needs are described in the following paragraphs.

Conserving moisture.-Most of the cultivated soils in the Hood River County Area are limited in productivity because of inadequate moisture. All moisture available from precipitation and irrigation, therefore, should be conserved and used efficiently.

Controlling erosion.-Many soils in the survey area have a surface layer no more than 10 inches thick. Further erosion will reduce the capacity of these soils to store moisture and supply plant nutrients. Tilling properly, maintaining the supply of organic matter (fig. 9), and preserving soil structure increase the water intake rate and help to control erosion.

Preserving soil structure.-Proper tillage and maintenance of organic-matter content are the two principal factors in building and preserving good soil structure.

Excessive tillage tends to reduce the organic-matter content and break up the soil aggregates. Thus, the soil is less permeable to water, air, and roots.

Maintaining organic matter.-Organic matter is the partially decomposed remains of plants and soil organisms. The organic-matter content of the soils in the Hood River County Area ranges from a high of 3 or 4 percent under native plant cover to a low of 1 percent after a long period of cultivation.

Organic matter binds the soil particles together in aggregates, and thus helps to preserve soil structure. It is the food source for soil organisms and nutrient for plants. The organic matter in the soil is continuously decomposing, and the supply must be renewed regularly. An adequate supply of organic matter can be maintained by

1. Returning all crop residue to the soil. Crop residue is the main source of organic matter. Organic matter is lost if residue is removed or otherwise destroyed.
2. Spreading barnyard manure on the field. In areas where fruit is grown, the supply of manure may be limited.
3. Growing grasses and legumes in the rotation. Grasses and legumes provide a supply of organic material that decomposes readily and does not compete with the crop for available nutrients, mostly nitrogen.
4. Using commercial fertilizer. Fertilization increases yields and the amount of crop residue. The decomposition of organic matter high in carbon can reduce yields unless a supply of nitrogen is provided.

Crops grown on soils in the Hood River County Area respond favorably to fertilization. Amount and type of fertilizer applied should be determined by the fertility level of the soil and the crop needs. Leaf analysis and soil tests are useful guides. Crops on some soils respond favorably to fertilizers containing zinc, boron, or sul-

Figure 8.-Interplanting strawberries in young pear orchard on Parkdale loam.

pur. Application of lime is sometimes beneficial. For additional information, consult the Experiment Station, the Extension Service, or the Soil Conservation Service.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These levels are defined in the following paragraphs.

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture and range, woodland, or wildlife habitat. (None in the Hood River Area.)

Class VI soils have severe limitations that make

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

Figure 9.-Pear orchard on Hood soils. Cover crop helps to maintain the organic-matter content.

them generally unsuitable for cultivation and limit their use largely to pasture and range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to pasture and range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class. They are designated by adding a small letter, *e, w, s, or c*, to the class numeral, for example, IIw. The letter *e* shows that the main limitation is risk of erosion; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w, s,* and *c,* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are usually designated by adding an Arabic numeral to the subclass symbol, for example, IIw-1 or IIIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In this survey, only the cultivated soils are grouped at three levels. The noncultivated soils are identified only by subclass.

Management by capability units

The capability units in the Hood River County Area are described on the pages that follow, and the use and management of the soils is suggested.

The names of soil series represented in a capability unit are given in the description of the capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the capability unit for each soil in the survey area, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

The one soil in this unit, Hood loam, 0 to 3 percent slopes, is well drained. Annual precipitation is 30 to 35 inches. The frost-free period is 150 to 180 days.

Permeability is moderate. Available water capacity is 11 to 13 inches. Water-supplying capacity is 16 to 18 inches. Typically, roots penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is suited to all crops commonly grown in the Hood River County Area and requires only minimum management. It is used mostly for apple and pear orchards. It can be irrigated with little risk of soil erosion.

CAPABILITY UNIT IIe-1

This unit consists of deep, well drained fine sandy loams and loams of the Culbertson, Hood, Oak Grove, Parkdale, and Van Horn series. Slopes are 0 to 8 percent. Annual precipitation is 30 to 50 inches. The frost-free period is 100 to 180 days.

Permeability is moderate to moderately slow. Available water capacity is 8 to 17 inches. Water-supplying capacity is 12 to 18 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are suited to all crops commonly grown in the Hood River County Area. They are used for fruit orchards, timber, grazing, and wildlife habitat. A moderate level of management is needed. Crops in some areas of Oak Grove soils respond to lime. If the slope is more than 3 percent, cover crops are needed in orchards to help control erosion and maintain the organic matter content.

CAPABILITY UNIT IIe-2

Only Cumulic Haploxerolls is in this unit. These are deep, well drained and moderately well drained loams. Slopes are 0 to 3 percent. Annual precipitation is 30 to 40 inches. The frost-free period is 150 to 180 days.

Permeability is moderate to moderately slow. Available water capacity and water-supplying capacity are variable. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight. Some areas are subject to overflow.

These soils are used for irrigated hay and pasture and for wildlife habitat. The varying texture, permeability, and available water capacity make proper application of irrigation water difficult. Unless the water is properly controlled, some areas are too wet and others remain dry. Careful irrigation also is needed to prevent loss from leaching of applied nitrogen fertilizer. Protection against flooding is needed in some areas.

CAPABILITY UNIT IIw-1

This unit consists of deep, somewhat poorly drained loams and silt loams of the Dee and Wyeast series and the Van Horn variant. Slopes are 0 to 12 percent. Annual precipitation is 30 to 45 inches. The frost-free period is 100 to 180 days.

Permeability is moderate to slow. Available water capacity is 6 to 17 inches. Water-supplying capacity is less than 20 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

If drained, these soils are suited to all crops commonly grown in the Hood River County Area. Some fruits, mainly pears, are grown on undrained soils, but production can be increased by drainage.

The wide range in available water capacity in Wyeast

soils and the Van Horn variant makes proper application of irrigation water difficult. Those soils need more frequent and smaller applications than Dee soils, which have an available water capacity of 8 to 10 inches. Also, Wyeast soils have a slowly permeable brittle layer between depths of 28 and 45 inches. This layer further complicates the irrigation and drainage of those soils. Careful application of irrigation water is needed on the Van Horn variant to prevent loss from leaching of applied nitrogen fertilizer. All crops respond to fertilization.

CAPABILITY UNIT IIIe-1

This unit consists of well drained to somewhat poorly drained loams of the Culbertson, Dee, Hood, Oak Grove, Parkdale, and Van Horn series. Slopes are 8 to 20 percent. Annual precipitation is 30 to 50 inches. The frost-free period is 100 to 180 days.

Permeability is moderate to moderately slow. Available water capacity is 8 to 17 inches. Water-supplying capacity is 12 to 20 inches. Roots penetrate to a depth of 40 to 60 inches or more. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for fruit orchards, irrigated pasture and hay, and wildlife habitat. A high level of management is needed.

Perennial cover crops are needed in orchards to control erosion and to improve or maintain the organic-matter content.

Grass-legume hay and irrigated pasture are suited to the soils of this unit. Production of grass-legume hay ranges from 4 to 6 tons per acre.

Crops respond to fertilization. Fertilizer containing boron, zinc, and sulphur is needed in places. Lime is needed in some areas of Oak Grove soil. Dee soils are somewhat poorly drained and require careful application of irrigation water. Drainage is needed in some areas.

CAPABLITY UNIT IIIs-1

This unit consists of well drained fine sandy loams and gravelly sandy loams of the Wind River series and Wind River variant. Slopes are 0 to 8 percent. Annual precipitation is 30 to 35 inches. The frost-free period is 150 to 180 days.

Permeability is moderately rapid. Available water capacity is 3 to 8 inches. Water-supplying capacity is 3 to 14 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for fruit orchards, pasture, and wildlife habitat. Cover crops are needed to maintain the organic-matter content. Fertilizer containing boron, zinc, and magnesium is beneficial in some orchards.

Careful irrigation is needed to prevent loss from leaching of applied nitrogen fertilizer. Overirrigation is a hazard on some soils because of the low and moderate available water capacity. Frequent and small applications of irrigation water are needed on pasture, especially on the Wind River variant.

CAPABLITY UNIT IVe-1

This unit consists of well drained loams of the Culbertson, Hood, Oak Grove, and Parkdale series. Slopes are 20 to 40 percent. Annual precipitation is 30 to 50 inches. The frost-free period is 100 to 180 days.

Permeability is moderate to moderately slow. Available water capacity is 9 to 17 inches. Water-supplying capacity is 13 to 18 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is rapid, and the hazard of erosion is high.

These soils are used mostly for fruit orchards, pasture, hay, and wildlife habitat. Limitations are very severe, and careful management is needed.

Perennial cover crops are essential in fruit orchards for erosion control. Orchards respond to fertilization. The acreages in pasture and hay should be seeded only when necessary. Irrigation water management is important and complex because of the steep slopes. Crops in some areas respond to fertilizer containing magnesium, boron, and zinc.

CAPABILITY UNIT IVe-2

Only the Wamic variant is in this unit. These are well drained loams. Slopes range from 5 to 20 percent, but are mostly more than 12 percent. Annual precipitation is 25 to 35 inches. The frost-free period is 100 to 140 days.

Permeability is moderately slow. Available water capacity is 6 to 10 inches. Water-supplying capacity is 8 to 12 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is medium, and the hazard of erosion is moderate.

These soils are not irrigated. They are used mostly for hay, pasture, and wildlife habitat. In areas where slopes are more than 12 percent, they are used for timber.

Erosion is a hazard and should be kept at a minimum to insure adequate production levels. Hay, pasture, or range vegetation in at least good condition is needed to provide sufficient protection against erosion. Pasture and hay crops should be carefully managed to provide sufficient ground cover. The legume-grass mixture selected should provide reasonable production and protection against erosion. Proper grazing use and season of use and a grazing system are needed to maintain or improve range vegetation.

CAPABILITY UNIT IVe-3

This unit consists of well drained fine sandy loams of the Wind River series and gravelly sandy loams of the Wind River variant. Slopes are 8 to 30 percent. Annual precipitation is 30 to 35 inches. The frost-free period is 150 to 180 days.

Permeability is moderately rapid. Available water capacity is 3 to 8 inches. Water-supplying capacity is 6 to 14 inches. Typically, roots penetrate to a depth of more than 60 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

These soils are used for fruit orchards, pasture, and wildlife habitat. Limitations are very severe because of the low to moderate available water capacity and the steep slopes.

Careful management of irrigation water is needed. The Wind River variant is easily overirrigated because it holds only 3 to 5 inches of available water. Excessive applications of water result in leaching and loss of nitrogen and other plant nutrients.

These soils are well suited to apples and winter pears, but cover crops are needed to control erosion and maintain the organic-matter content. Fertilizer con-

taining boron, zinc, and magnesium is beneficial in some areas.

CAPABILITY UNIT IVw-1

Only Cumulic Haplaquolls, very level, is in this unit. These are somewhat poorly drained to poorly drained silt loams, loams, sandy loams, and clay loams. Slopes are 0 to 3 percent. Annual precipitation is 30 to 45 inches. The frost-free period is 100 to 180 days.

Permeability is moderate to moderately slow. Available water capacity and water-supplying capacity are variable. Typically, roots penetrate to a depth of 20 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight. The soils are subject to overflow. Ponding occurs during months of high precipitation.

These soils are used for pasture, range, and wildlife habitat. The high water table, which is within a depth of 1 1/2 to 2 feet, and hazard of overflow severely restrict the use of these soils. The vegetation is mostly water-tolerant plants.

Protection from flooding is needed. Lack of suitable outlets makes drainage difficult.

CAPABILITY UNIT IVs-1

This unit consists of well drained Rockford stony loams. Slopes are 0 to 12 percent. Annual precipitation is 30 to 45 inches. The frost-free period is 120 to 180 days.

Permeability is moderately slow. Available water capacity is 4 to 7 inches. Water-supplying capacity is 10 to 14 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for fruit orchards, pasture, hay, and wildlife habitat. Apples are suited and produce high yields. Yields are moderately low for pears. Permanent cover crops are needed to control erosion and to maintain the organic-matter content. The stones hinder orchard management and reduce the available water capacity.

These soils are suited to pasture and hay crops. Careful irrigation is needed because of the low to moderate water capacity. Overirrigation leaches nitrogen and other plant nutrients below the plant roots. Crops respond to fertilization. Fertilizer containing magnesium, boron, and zinc is beneficial in some areas.

CAPABILITY SUBCLASS IVe

This unit consists of well drained soils of the Bins, Culbertson, Hutson, Ketchly, and Oak Grove series and Wamic variant. These soils formed in loess, volcanic ash and conglomerate and in colluvium derived from basalt and andesite. Slopes are 0 to 60 percent. Annual precipitation is 25 to 90 inches. The frost-free period is 30 to 180 days.

Permeability is moderately rapid to moderately slow. Available water capacity is 6 to 14 inches. Water-supplying capacity ranges from less than 8 to 20 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow to rapid, and the hazard of erosion is slight to high.

These steep soils are used for range, woodland, wildlife habitat, and water supply. For suggestions on use and management, see "Wildlife" and "Woodland."

CAPABILITY SUBCLASS VIs

This unit consists of well drained soils of the Bald, Bindle, Bodell, Divers, Rockford, Wyeth, and Yallani series. These soils formed in loess and volcanic ash and in colluvium derived from basalt and andesite. Slopes are 0 to 45 percent. Annual precipitation is 25 to 90 inches. The frost-free period is 30 to 180 days.

Permeability is moderately slow to moderately rapid. Available water capacity is 1 to 10 inches. Typically, roots penetrate to a depth of 12 to 60 inches or more. Runoff is slow to rapid, and the hazard of erosion is slight to high.

Shallowness in places, steep slopes, and coarse fragments in the soil limit the use of these soils to woodland, wildlife habitat, and water supply. For suggestions on use and management, see "Wildlife" and "Woodland."

CAPABILITY SUBCLASS VIIe

This unit consists of well drained soils of the Bins, Frailey, Hutson, and Ketchly series and Xerumbrepts. These soils formed in loess, volcanic ash, conglomerate, material weathered from sandstone, and colluvium derived from basalt and andesite. Slopes are 30 to 70 percent. Annual precipitation is 25 to 90 inches. The frost-free period is 30 to 180 days.

Permeability is moderately rapid to moderately slow. Available water capacity is 6 to 14 inches. Water-supplying capacity is 10 to 20 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is medium to rapid, and the hazard of erosion is high.

These very steep soils are used for woodland, wildlife habitat, and water supply. For suggestions on use and management, see "Wildlife" and "Woodland."

CAPABILITY SUBCLASS VIIs

This unit consists of mostly well drained soils of the Bald, Bindle, Bodell, Divers, Rockford, Wyeth, and Yallani series, Xerofluvents, and Rock outcrop. The soils formed in basalt colluvium, loess, volcanic ash, and conglomerate. Slopes are 0 to 75 percent. Annual precipitation is 25 to 90 inches. The frost-free period is 30 to 180 days.

Permeability is mostly moderate. Available water capacity is 1 to 10 inches. Water-supplying capacity is 4 to 20 inches. Typically, roots penetrate to a depth of 12 to 60 inches or more. Runoff is slow to rapid, and the hazard of erosion is slight to high.

Shallowness in places, very steep slopes, and coarse fragments in the soil limit the use of these soils to woodland, wildlife habitat, and water supply. For suggestions on use and management, see "Wildlife" and "Woodland."

CAPABILITY SUBCLASS VIIIs

This unit consists of Lava flows, Rock outcrop, and Rubble land complex. The barren basalt cliffs and rolling to very steep rocky areas are of little value for woodland or grazing. These mapping units provide wildlife habitat, water supply, and a source of material for roads and other construction.

CAPABILITY SUBCLASS VIIIw

Only Riverwash is in this unit. It is subject to overflow, deposition, and removal during high water. It

has little value for woodland or grazing. Riverwash provides wildlife habitat and a source of material for roads and other construction.

Irrigated Apples and Pears

Soils of the Hood River County Area are grouped according to the management needed for orchards. Three groups are recognized. The soils in groups 1 and 2 are suitable for apple and pear orchards. Management is suggested for the soils in group 1. The same management is to be assumed for the soils in group 2 except for the considerations stated.

Group 1 consists of soils in capability units I-1, IIe-1, IIIe-1, IIIs-1, IVe-1, IVe-3, and IVs-1.

Apple and pear orchards can be planted in soils seeded to a cover crop by using a tree auger or rotated strips, or in soils that have been plowed, disked two or three times, and harrowed.

Delicious and Newtown apples and Bartlett, Bosc, and d'Anjou pears are the fruit trees generally grown. The trees can be planted from late in fall to early in March. Apples are planted at low to high density, 100 to 400 trees per acre, depending on the type of planting and the size of tree, for example, dwarf (fig, 10) or standard (fig. 11). Pears are planted at low to medium density, 100 to 300 trees per acre.

Soil tests and leaf analysis can be used as a guide in applying fertilizer. Nitrogen fertilizer is commonly needed. Some soils require fertilizer containing trace elements, such as magnesium, boron, or zinc, which can be applied by foliar spraying.

Lime, if the need is indicated by soil tests, should be disked into the soil before it is seeded to a cover crop.

An area 3 to 4 feet wide free of vegetation is maintained around each tree until it is 3 to 5 years old and well established. Cover crops are mowed during the summer to maintain a desirable height.

A permanent cover crop is seeded between the rows in April or September and is then fertilized and irrigated.

Permanent cover crops are needed to control erosion and to maintain an adequate supply of organic matter.

Local specialists can be consulted on control of disease and insects.

Group 2 includes soils in capability unit IIw-1. These soils are not well suited to apples, but are suited to pears. Drainage increases production on some of these soils. Other management needs are similar to those suggested for the soils in group 1.

Group 3 includes soils in capability groups IIe-2, IVe-2, and IVw-1. These soils are generally not suited to fruit orchards.

Figure 10.-Semidwarf apple trees on Oak Grove soils.

Figure 11.-Hedgerow planting of apple trees on Van Horn soils.

Irrigated Pasture and Hay

Soils of the Hood River County Area are grouped according to the management needed for irrigated pasture and hay. Three groups are recognized. Management is suggested for the soils in group 1. The same management is assumed for the soils in group 2. Exceptions are noted.

Group 1 consists of soils in capability units I-1, IIe-1, IIe-2, IIIe-1, IIIs-1, IVe-2, IVe-3, and IVw-1.

A fine seedbed is needed. Preparation consists of plowing, disking two to five times, harrowing two to five times, and cultipacking. For suitable seeding mixtures, refer to the interagency seeding guide. The kind and amount of fertilization should be determined according to the results of soil tests and the information in the Oregon State University Fertilizer Guide. Liming, where the need is indicated, should be applied before disking in the amount determined by soil tests. Pasture can be seeded in spring or early in fall. Plants should be well established before pasture is grazed. Mowing and light harrowing are needed periodically to spread droppings and maintain a uniform growth.

Irrigation water is applied by sprinklers. Proper timing, the rate of application, and the distribution of irrigation water are to be considered in good, water management. The gross requirement is about 12 to 16 inches of irrigation water from June 1 to September 20.

Under good pasture management, fields are divided to provide a 2 1/2 to 3 1/2 week regrowth period in each field. The season of use is April through October.

Group 2 consists of soils in capability unit IIw-1. In addition to the management suggested in the foregoing paragraphs, drainage is needed in some areas.

Group 3 consists of soils in capability unit IVe-1. These soils are so steep that they are not suited to irrigated pasture and hay.

Yields Per Acre

Table 2 lists the average yields per acre that can be expected of the principal crops grown in the survey area under a high level of management. In any given year, yields may be higher or lower than those indicated because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to the soil, is not commonly grown on the soil, or is not commonly irrigated.

The predicted yields are based mainly on the expe-

rience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management is assumed in predicting the yields. Hay and pasture yields are predicted for varieties of grasses and legumes suited to the soil.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection against flooding; proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage, including timely tillage and seedbed preparation when soil moisture is favorable; 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; harvest with the smallest possible loss; and timely fieldwork.

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

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

Crops other than those shown in table 2 are grown in the survey area, but the acreage is small and no yield data were available. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information on productivity and management of the soils for those crops.

Woodland

The principal forest cover types (8) in the area surveyed are Pacific Douglas-fir, Pacific ponderosa pine, interior ponderosa pine, and Douglas-fir-western hemlock.

The Columbia River Gorge has a considerable influence on the weather of the Hood River County Area and to a large extent determines the composition and growth of the plant community at the higher elevations. The climate of the Willamette Valley is thought to influence the composition and growth of the plant community at the lower elevations. This influence in the Hood River County Area is believed to extend eastward to within 1 to 5 miles of the Wasco County line. Therefore, interpretations for the Pacific form of Douglas-fir are provided for Hood River County Area.

The information on the pages that follow can help landowners and woodland managers in planning, establishing, and managing tree crops.

Equipment limitation is based on soil characteristics and topographic features that restrict or prohibit the use of conventional equipment in road construction,

JAMES T. BEENE, forester, Soil Conservation Service, helped prepare this section.

fire control, tree planting, stand improvement, and harvest of wood crops. Stoniness, steepness of slope, excessive clay in the surface layer, and instability of the soil when wet are examples of equipment limitations.

Seedling mortality refers to the mortality of naturally occurring or planted tree seedlings, as influenced by the kind of soil or topographic condition when plant competition is not a factor. *Slight* indicates an expected loss of 0 to 25 percent, *moderate,* 25 to 50 percent, and *severe,* more than 50 percent. It is assumed that quality planting stock is used and that seed sources are adequate.

Plant competition is the degree to which undesirable plants invade openings in the tree canopy. Considered in the ratings in table 3 are available water capacity, fertility, drainage, and degree of erosion. *Slight* means that plant competion does not prevent adequate natural regeneration and early growth or interfere with seedling development. *Moderate* means that competition delays natural or artificial establishment and growth rate, but does not prevent the development of fully stocked normal stands; *severe* means that competition prevents adequate natural or artificial regeneration unless the site is properly prepared, weeded, and otherwise well managed.

Management and productivity

The soils in the survey area are grouped according to their suitability for woodland use and management. In table 3 each woodland group is identified by a three part symbol, for example, 4o1, 4x1, and 4x2.

The first numeral in the symbol indicates the degree of productivity of the soil. The numeral *1* indicates *very high productivity*; *2, high; 3, moderately high; 4, moderate;* and *5, low*. These ratings, related to site index, are based on research, measurements by foresters and soil scientists, and the experience of forest land managers. Site index is the average height, in feet, of the dominant and codominant trees at age 100 years (3), (5), (6). Conversions of average site index into volumetric growth and yield can be made by referring to tables 4 and 5.

The second part of the symbol is a letter. The letter *o* indicates no significant limitation or restriction. The letters x, *f,* and *r* indicate the major kind of soil limitation. The letter *x* indicates stoniness or rockiness, *f,* a high content of coarse fragments, and *r,* steep slopes.

The last numeral in the symbol differentiates woodland groups that have identical first and second parts. Soils in woodland group 4f1, for example, may be better suited to a different species or require somewhat different management than soils in group 4f2.

In table 3 each soil in the survey area is rated for various factors to be considered in management. The degree of major soil limitation is expressed as slight, moderate, or severe.

The erosion hazard is based on steepness of slope and the depth and erodibility of the soil.

WOODLAND GROUP 3x1

This group consists of Rockford soils. These are well drained stony and very stony loams on uplands. They

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

formed in very stony, medium and moderately fine textured glacial outwash from basalt and andesite. Slopes are 0 to 30 percent. Elevation is 100 to 2,000 feet. Annual precipitation is 30 to 45 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Permeability is moderately slow. The water-supplying capacity is 10 to 14 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially these soils are moderately high in productivity. Equipment limitation is severe because of the large number of stones on the surface. Seedling mortality is moderate because of the large content of coarse fragments in the profile. In places plant competition delays seedling establishment and growth.

Ponderosa pine is best suited. There are also stands of Douglas-fir and Oregon white oak. The midstory is hazel, willow, and snowberry.

WOODLAND GROUP 3fl

This group consists of Yallani soils. These are well drained stony loams in mountainous areas. They formed in windlain silts, volcanic ash, and stony colluvium from andesite and basalt. Slopes are 8 to 30 percent. Elevation is 1,500 to 3,000 feet. Annual pre-

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All tables have been updated and are available as a separate document.

cipitation is 40 to 60 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderately rapid. The water-supplying capacity is 13 to 17 inches. Roots penetrate to a depth of more than 60 inches.

Potentially these soils are moderately productive. The erosion hazard is moderate where slopes are steeper than 15 percent. Moderate seedling mortality on hilltops and south-facing slopes is caused by the large content of rock fragments in the soil profile. In places plant competition delays seedling establishment and growth.

Douglas-fir is best suited. Ponderosa pine is on hilltops and south-facing slopes. Grand fir is on north-facing slopes and at the higher elevations. The midstory is willow, vine maple, hazel, snowberry, and oceanspray.

WOODLAND GROUP 3f2

This group consists of Yallani soils. These are well drained stony loams in mountainous areas. They formed in windlain silts, volcanic ash, and stony colluvium from andesite and basalt. Slopes are 30 to 65 percent. Elevation is 1,500 to 3,000 feet. Annual precipitation is 40 to 60 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderately rapid. The water-supplying capacity is 13 to 17 inches. Roots penetrate to a depth of more than 60 inches.

Potentially these soils are moderately productive. The erosion hazard is high. Equipment limitation is moderate because of steepness of slope. In places plant competition delays seedling establishment and growth.

Douglas-fir is best suited. Ponderosa pine and grand fir are at the lower elevations. The midstory is willow, vine maple, hazel, snowberry, and oceanspray.

WOODLAND GROUP 3ol

This group consists of Parkdale soils. These are well drained loams on uplands. They formed in volcanic ash and mudflows. Slopes are 0 to 40 percent. Elevation is 1,000 to 2,500 feet. Annual precipitation is 35 to 50 inches. Runoff is slow to rapid, and the hazard of erosion is slight to high. Permeability is moderate. The water-supplying capacity is 16 to 18 inches. Roots penetrate to a depth of more than 60 inches.

Potentially these soils are moderately productive. In places plant competition delays seedling establishment and growth.

Douglas-fir is dominant and best suited. There are also stands of grand fir and ponderosa pine. The midstory is willow, dogwood, hazel, and vine maple.

WOODLAND GROUP 4fl

This group consists of Bindle and Wyeth soils. These are well drained gravelly loams and very gravelly loams in mountainous areas. These soils formed in windlain silts, volcanic ash, and stony colluvium derived from andesite and basalt. Slopes are 1 to 45 percent. Elevation is 200 to 3,500 feet. Annual precipitation is 30 to 50 inches. Runoff is slow to rapid, and the hazard of erosion is slight to high. Permeability is moderate to moderately rapid. The water-supplying capacity is 13 to 20 inches. Roots penetrate to a depth of 20 to 60 inches or more.

Potentially these soils are moderately productive.

The erosion hazard is moderate where slopes are steeper than 15 percent. Moderate seedling mortality on hilltops and south-facing slopes is caused by the large content of rock fragments in the soil profile. In places plant competition delays seedling establishment and growth.

Douglas-fir is best suited. Ponderosa pine is on hilltops and south-facing slopes. Grand fir is on north-facing slopes and at the higher elevations. The midstory is willow, vine maple, hazel, snowberry, and oceanspray.

WOODLAND GROUP 4f2

This group consists of Bindle and Wyeth soils. These are well drained gravelly loams and very gravelly loams in mountainous areas. They formed in windlain silts, volcanic ash, and stony colluvium from andesite and basalt. Slopes are 30 to 75 percent. Elevation is 200 to 3,500 feet. Annual precipitation is 30 to 50 inches. Runoff is medium to rapid, and the hazard of erosion is high. Permeability is moderate to moderately rapid. The water-supplying capacity is 13 to 20 inches. Roots penetrate to a depth of 20 to 60 inches or more.

Potentially these soils are moderately productive. The erosion hazard is severe. Equipment limitation is moderate because of steepness of slope. In some places plant competition delays seedling establishment and growth.

Douglas-fir is best suited. Ponderosa pine and grand fir are at the lower elevations. The midstory is willow, vine maple, hazel, snowberry, and oceanspray.

WOODLAND GROUP 4f3

The one soil in this group, Divers gravelly loam, 3 to 30 percent slopes, is a well drained soil in mountainous areas. It formed in mixed ash, medium textured mudflows, and colluvium weathered from basalt and andesite. Elevation is 3,000 to 4,800 feet. Annual precipitation is 50 to 90 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability is moderately rapid. The water-supplying capacity is 14 to 20 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially this soil is moderately productive. The erosion hazard is moderate where slopes are steeper than 15 percent.

Douglas-fir, grand fir, noble fir, western white pine, and western hemlock are suited. Douglas-fir is best suited at the lower elevations. Noble fir is best suited at the higher elevations. The midstory is manzanita, golden chinquapin, rhododendron, and huckleberry.

WOODLAND GROUP 4f4

The one soil in this group, Divers gravelly loam, 30 to 65 percent slopes, is a well drained soil in mountainous areas. It formed in mixed ash, medium textured mudflows, and colluvium weathered from basalt and andesite. Elevation is 3,000 to 4,800 feet. Annual precipitation is 50 to 90 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderately rapid. The water-supplying capacity is 14 to 20 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially this soil is moderately productive. The erosion hazard is high. Equipment limitation is moderate because of steepness of slope.

Douglas-fir, grand fir, noble fir, western white pine, and western hemlock are suited. Douglas-fir is best suited at the lower elevations. Noble fir is best suited at the higher elevations. The midstory is manzanita, golden chinquapin, rhododendron, and huckleberry.

WOODLAND GROUP 4f5

The one soil in this group, Bald cobbly loam, 5 to 45 percent slopes, is a well drained soil in mountainous areas. It formed in mixed loess, volcanic ash, and colluvium weathered from basalt. Elevation is 200 to 3,000 feet. Annual precipitation is 25 to 40 inches. Runoff is slow to rapid, and the hazard of erosion is slight to high. Permeability is moderate. The water-supplying capacity is 12 to 15 inches. Roots penetrate to a depth of 20 to 40 inches.

Potentially this soil is moderately productive. The erosion hazard and equipment limitation are moderate on the steeper soils. Seedling mortality is severe because of the large content of coarse fragments in the soil profile.

Ponderosa pine is best suited. There are also stands of Douglas-fir and Oregon white oak. The midstory is hazel, wild lilac, snowberry, bitter cherry, and oceanspray.

WOODLAND GROUP 4f6

The one soil in this group, Bald very cobbly loam, 45 to 75 percent slopes, is a well drained soil in mountainous areas. It formed in volcanic ash and colluvium weathered from basalt. Elevation is 200 to 3,000 feet. Annual precipitation is 25 to 40 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderate. The water-supplying capacity is 12 to 15 inches. Roots penetrate to a depth of 20 to 40 inches.

Potentially this soil is moderately productive. The erosion hazard is high because of steepness of slope. Equipment limitation is moderate on soils where slopes are less than 60 percent, and severe. on soils where slopes are greater than 60 percent. Seedling mortality is severe because of the large content of rock fragments in the soil profile.

Ponderosa pine is best suited. There are also stands of Douglas-fir and Oregon white oak. The midstory is hazel, wild lilac, snowberry, bitter cherry, and oceanspray.

WOODLAND GROUP 4r1

This group consists of Bins, Culbertson, Frailey, Ketchly, and Oak Grove soils and Xerumbrepts, very steep. These are well drained loams and gravelly loams on old dissected terraces and in mountainous areas. These soils formed in volcanic ash, loess, stony colluvium, and deep clayey mudflows. Slopes are 30 to 70 percent. Elevation is 400 to 3,800 feet. Annual precipitation is 25 to 45 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderate to moderately slow. The water-supplying capacity is 10 to 20 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially these soils are moderately productive. The erosion hazard is severe. Equipment limitation is moderate because of steepness of slope. In places plant competition delays seedling establishment and growth.

Douglas-fir is best suited. Ponderosa pine is on

south-facing slopes. Grand fir is on north-facing slopes and at the higher elevations. Oregon white oak grows sporadically on Culbertson, Frailey, and Oak Grove soils and on Xerumbrepts, very steep, but it dies out as the stand matures. The midstory is hazel, willow, and vine maple.

WOODLAND GROUP 4r2

The one soil in this group, Hutson fine sandy loam, 30 to 65 percent slopes, is a well drained soil in very steep mountainous areas. It formed in volcanic ash and mixed colluvium high in pyroclastic material. Elevation is 2,400 to 4,600 feet. Annual precipitation is 50 to 90 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderately rapid. The water-supplying capacity is 14 to 20 inches. Roots penetrate to a depth of more than 60 inches.

Potentially this soil is moderately productive. The erosion hazard is severe. Equipment limitation is moderate because of steepness of slope.

Douglas-fir is suited at the lower elevations. Grand fir, western white pine, western hemlock, and noble fir are suited at the higher elevations. The midstory is willow, vine maple, golden chinquapin, and huckleberry.

WOODLAND GROUP 4o1

This group consists of Bins, Culbertson, Oak Grove, and Ketchly soils. These are well drained loams on old dissected terraces. They formed in volcanic ash, loess, stony colluvium, and deep clayey mudflows. Slopes are 0 to 35 percent. Elevation is 400 to 2,500 feet. Annual precipitation is 35 to 50 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Permeability is moderate to moderately slow. The water-supplying capacity is 13 to 18 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially these soils are moderately productive. In places plant competition delays seedling establishment and growth.

Douglas-fir is best suited. There are also stands of grand fir and ponderosa pine. The midstory is Oregon white oak, willow, dogwood, hazel, and vine maple.

WOODLAND GROUP 4o2

The one soil in this group, Hutson fine sandy loam, 0 to 30 percent slopes, is a well drained soil in mountainous areas. It formed in volcanic ash and, mixed colluvium high in pyroclastic material. Elevation is 2,400 to 4,600 feet. Annual precipitation is 50 to 90 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderately rapid. The water-supplying capacity is 14 to 20 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially this soil is moderately productive. The erosion hazard is moderate where slopes are steeper than 15 percent.

Douglas-fir, grand fir, noble fir, western white pine, and western hemlock are suited. Douglas-fir is best suited at the lower elevations. Noble fir is best suited at the higher elevations. The midstory is willow, vine maple, golden chinquapin, and huckleberry.

WOODLAND GROUP 5o1

Only the Wamic variants are in this group. These are well drained loams on uplands. They formed in mixed loess and volcanic ash deposited on moderately fine textured colluvium. Slopes are 12 to 40 percent. Elevation is 1,000 to 2,000 feet. Annual precipitation is 25 to 35 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability is moderately slow. The water-supplying capacity is 8 to 12.5 inches. Roots penetrate to a depth of 40 to 60 inches or more.

Potentially these soils are moderately low in productivity. The erosion hazard is moderate where slopes are less than 20 percent and severe where slopes are greater than 20 percent. Seedling mortality is severe. In some places plant competition prevents seedling establishment and growth unless there is intensive site preparation and maintenance.

Ponderosa pine is best suited. There are also stands of Douglas-fir. Oregon white oak increases if the conifers are removed. The midstory is bitterbrush, snowberry, and oak sprouts.

Wildlife

The Hood River County Area, which is in the Cascade Mountains near 11,235-foot high Mt. Hood, provides habitat for one or more species of wildlife. The mountains significantly affect the climate of the area and strongly influence the surrounding flora and fauna. For example, the cony, which normally is found at high elevations, inhabits old rock slides above the Columbia River at elevations of less than 200 feet.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife either will be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 6 the soils in the survey area are rated according to their potential for the main kinds of wildlife habitat in the Area. This information can be used in

1. Planning the use of parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.
4. Determining areas that are suitable for acqui sition and management for wildlife.

The potential of the soil is expressed as good, fair, poor, or very poor. A rating of good means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated

ROBERT A. CORTHELL, biologist, Soil Conservation Service, helped prepare this section.

purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, wheat, oats, barley, and sunflowers. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considered.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, bromegrass, timothy, orchardgrass, clover, alfalfa, and trefoil. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considered.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are yarrow, lupine, balsamroot, wheatgrass, fescue, and bluegrass. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considered.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, maple, alder, dogwood, hazelnut, blackberry, oregongrape, and huckleberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Siberian peashrub, autumn-olive, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, hemlock, Douglas-fir, true fir, yew, and cedar. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are huckleberry, rhododendron, bitterbrush, and snowberry. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are rushes, sedges, reeds, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness.

Shallow water areas have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of croplands, pastures, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted are California quail, pheasant, meadowlark, robin, cottontail rabbit, coyote, and squirrel.

Woodland habitat consists of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are wild turkey, ruffled grouse, jay, thrush, owl, woodpecker, squirrel, marten, raccoon, deer, elk, and black bear.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Examples of wildlife attracted to this habitat are antelope, white-tailed deer, desert mule deer, buffalo, j avelina, chukar, scaled quail, sage grouse, meadowlark, and lark bunting.

Wildlife suitability groups

The soils in the Hood River County Area having similar characteristics have been grouped according to their potential as wildlife habitat. The three groups are described in the following paragraphs. Each soil in the area is rated in table 6 for the various habitat elements and the kinds of wildlife habitat.

WILDLIFE GROUP 1

This group consists of well drained to poorly drained, nearly level to rolling loamy soils on broad terraces and uplands. These soils formed in mixed alluvium, volcanic ash, silty lacustrine deposits, deep clayey mudflows, and glacial outwash. The native vegetation is ponderosa pine, Douglas-fir, Oregon white oak, shrubs, grasses, and forbs. Elevation is 100 to 2,500 feet. Average annual precipitation is 25 to 50 inches. Average

annual air temperature is 45° to 50° F., and the frost-free period is 100 to 180 days.

These soils are used almost exclusively for fruit orchards, which provide poor habitat for wildlife. The native plant community, however, has high potential for wildlife habitat.

Big game animals in the survey area are black-tailed deer and black bear. Nongame animals are raccoon, bobcat, coyote, skunk, rabbit, squirrel, mink, mountain beaver, and weasel.

Upland game birds are ring-necked pheasant, California quail, ruffed grouse, mountain quail, dove, and band-tailed pigeon. Nongame birds are the hawk, owl, crow, raven, jay, woodpecker, flycatcher, heron, shorebird, meadowlark, and robin, and other songbirds, many of which are seasonally abundant. Waterfowl populations are low and are limited mostly to streams and ponds (fig. 12) at the lower elevations.

Streams have limited populations of rainbow trout, cutthroat trout, coho salmon, chinook salmon, and steelhead trout.

Pond construction is limited in some soils but good in others (fig. 13).

Fish production is fair in ponded waters.

WILDLIFE GROUP 2

This group consists of well drained, steep to very steep loamy soils on uplands. These soils formed in mixed loess, volcanic ash, mudflows, and colluvium weathered from basalt and andesite. The native vegetation is Douglas-fir, grand fir, ponderosa pine, Oregon white oak, shrubs, and forbs. Elevation is 200 to 3,600 feet. Average annual precipitation is 25 to 50 inches. Average annual air temperature is 42° to 51° F., and the frost-free period is 50 to 180 days.

These soils provide important wildlife habitat. Because of the varied plant community and the range in elevation, they provide habitat for many species.

Big game animals in the survey area are black-tailed deer (fig. 14), Roosevelt elk, and black bear. Smaller animals are raccoon, bobcat, coyote, mountain beaver, rabbit, squirrel, woodrat, marten, mink, skunk, mice, and mole.

Habitat is also provided for blue and ruffed grouse, wild turkey, mountain quail, band-tailed pigeon, dove, hawk, owl, raven, jay, woodpecker, flycatcher, heron, and thrush and other songbirds, many of which are seasonally abundant.

Streams have fair to poor populations of rainbow trout, cutthroat trout, steelhead trout, coho salmon, and chinook salmon.

The opportunity for pond construction is limited by topography. Fish production is fair in ponded waters.

Figure 12.-Waterfowl nest and rear young near large ponds along the Columbia River.

WILDLIFE GROUP 3

This group consists of well drained, rolling loamy soils on ridgetops and steep to very steep loamy soils on sides of canyons. These soils formed in mixed volcanic ash, medium textured mudflows, and colluvium weathered from basalt and andesite. The native vegetation is western hemlock, mountain hemlock, grand fir, Douglas-fir, noble fir, shrubs, and forbs. Elevation is 1,500 to 4,800 feet. Average annual precipitation is 40 to 90 inches, much of which is snow. Average annual air temperature is 38° to 45° F., and the frost-free period is 30 to 60 days.

The native plant community reflects the influence of the high Cascade Mountains and Mt. Hood. The climate is cold. Many kinds of wildlife seasonally occupy the habitat provided by this predominantly forested plant community.

Black-tailed deer, Roosevelt elk, and black bear are seasonally present. Small animals are rabbit, squirrel, mountain beaver, cony, bobcat, coyote, raccoon, marten, and mink.

In limited population are blue and ruffed grouse, mountain quail, band-tailed pigeon, and a few wild turkeys. Also in the area are hawk, owl, raven, jay, Clarke's nutcracker, woodpecker, flycatcher, varied thrush, towhee, and many other small birds.

Streams are inhabited by rainbow trout, cutthroat trout, steelhead trout, coho salmon, and chinook salmon.

Unfavorable soil characteristics and cold temperatures limit fish pond construction. Ponded waters in this area are not so productive as in most areas.

Recreation

Knowledge of soils is needed in planning, developing, and maintaining areas used for recreation. In table 7 the soils are rated according to their limitations for camp areas, picnic areas, playgrounds, and paths and

Figure 13.-Pond in nearly level Cumulic Haplaquolls.

trails. Limitations are expressed as slight, moderate, and severe. Restrictive features are listed if the degree of limitation is more than slight.

A slight limitation indicates that soil properties are favorable for the rated use. This degree of limitation is minor and can be overcome easily. Good performance and low maintenance can be expected.

A moderate limitation indicates that soil properties are moderately favorable for the rated use. During some part of the year the performance of the planned facility is somewhat less desirable than for soils rated *slight. A* moderate limitation can be overcome or modified by special planning, design, or maintenance. Some soils rated *moderate,* for example, require artificial drainage or control of runoff to reduce erosion.

A severe limitation indicates one or more unfavorable properties. Examples are steep slopes, bedrock near the surface, flood hazard, a seasonal high water table, or low bearing strength. The limitation generally requires major soil reclamation, special design, or intensive maintenance.

Camp areas are used intensively for tents and small camp trailers, and the associated activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. Features affecting use of the soil as camp areas are wetness, flooding during the season of use, permeability, slope, soil texture, dust, rock outcrop, and number of pebbles, cobbles, or stones on the surface.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use withstand heavy foot traffic. Soil features affecting this use are wetness, flooding during season of use, permeability, slope, soil texture, dust, rock outcrop and number of pebbles, cobbles, or stones on the surface, and depth to bedrock.

Picnic areas are attractive natural or landscaped tracts. These areas are subject to heavy foot traffic. Most of the vehicular traffic is confined to access roads. Soil features affecting this use are wetness, flooding during the season of use, slope, surface texture, dust, rock outcrop, and number of pebbles, cobbles, or stones on the surface.

Paths and trails are used for local and cross country travel on foot or horseback. Design and layout should require little or no cutting or filling. Soil features affect

Figure 14.-Black-tailed deer wintering on Wamic and Ketchly soils.

ing this use are wetness, flooding during season of use, slope, surface texture, dust, rock outcrop, and number of pebbles, cobbles, or stones on the surface.

The information in table 7 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, in table 12, and interpretations for dwellings without basements and for local roads and streets, in table 13.

Engineering

This part of the survey is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bed rock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

ELWIN A. Ross, engineer, Soil Conservation Service, helped prepare this section.

Information in this section of the soil survey can be helpful to those who

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

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All tables have been updated and are available as a separate document.

Tables 8, 9, 10, and 11 show results of engineering laboratory tests on soil samples, estimates of soil properties significant in engineering, physical and chemical properties of soils, and soil and water features.

Estimated interpretations in tables 12, 13, 14, and 15 are based on the engineering properties shown in tables 8, 9, and 11, test data for soils in the Hood River County Area and adjoining or nearby survey areas, and on the experience of engineers and soil scientists with these soils. In tables 12, 13, and 14 ratings summarize the limitations or suitability of the soils for the listed purposes. In table 15, Water Management, soil features not to be overlooked in planning, installation, and maintenance are listed.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* indicates soil properties generally favorable for the rated use, or in other words, limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* indicates soil properties so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required. *Very severe* indicates one or more soil properties so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

The information in this publication does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning in soil science. The Glossary defines many of these terms.

Classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the SCS engineers, Department of Defense, and others, and the AASHTO system adopted by the American Association of State Highway Transportation Officials. A comparison of these and other systems of size limits for soil separates can be found in the PCA Soil Primer (7).

In the Unified system (2) soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example, CL-ML.

The AASHTO system (1) classifies soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is assigned to one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils,

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All tables have been updated and are available as a separate document.

which have high bearing strength and are the best soils for subgrade, or foundation. At the other extreme, in group A-7, are clay soils, which have low strength when wet and are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 8. The estimated classification, without group index numbers,

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is given in table 9 for all soils mapped in the survey area.

Test data

Samples from 10 soils of the Hood, Oak Grove, Parkdale, Wind River, and Wyeast series representative of the Hood River County Area were tested by standard AASHTO procedures to help evaluate the soils for engineering purposes. Only selected layers of each soil were sampled. The results of these tests and the classification of each soil sample according to both the AASHTO and Unified systems are shown in table 8. The samples tested do not represent the entire range of soil characteristics in the Area, or even within the soil series sam-

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pled. The results of the tests, however, can be used as a general guide in estimating the physical properties of the soils. Tests made were for moisture-density relationships, grain-size distribution, liquid limit, and plasticity index.

In the moisture density, or compaction test, a sample of the soil material is compacted several times with a constant compactive effort, each time at a successively higher moisture content. The moisture content increases until the optimum moisture content is reached. After that the density decreases with increase in moisture content. The highest density obtained in the compaction testis termed "maximum dry density." Moisture-density data are important in construction, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The results of the mechanical analysis, obtained by combined sieve and hydrometer methods, can be used to determine the relative proportions of the different size particles that make up the soil sample. The percentage of fine-grained material determined by the hydrometer method should not be used in determining textural classes of soils.

Liquid limit and plasticity index are defined in the section "Soil Properties Significant in Engineering."

Soil properties significant in engineering

Estimates of soil properties significant in engineering are listed in table 9. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 9.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Soil texture is described in table 9 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Coarse fragments over 3 inches refers to percent by weight of rock fragments. In the Unified and AASHTO system these fragments are not considered in the classification.

Percent of material passing various sieve sizes is determined on a weight basis. The number 4 sieve is 4.7 millimeters in diameter, the number 10 is 2.0 millimeters, the number 40 is 0.42 millimeter, and the number 200 is 0.074 millimeter. In the Unified system, the fines (silt and clay) is the material passing the number 200 sieve. Gravel is that material retained on the number 4 sieve. The difference between what passes the number 4 sieve and what passes the number 200 sieve is sand. In the AASHTO system, the material passing the number 200 sieve is clay and silt. Gravel is the material retained on the number 10 sieve. The difference between what passes the number 10 sieve and what passes the number 200 sieve is sand.

The figures shown under each sieve size are obtained either by laboratory test data or by estimates based on USDA textural classes.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic

to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state.

The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 9, but in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

All estimates in table 9 have been rounded to the nearest 5 percent. Thus when the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percentage points), the classification in the marginal zone has been omitted.

Physical and chemical properties

Physical and chemical properties of soils are listed in table 10. The properties considered are described in the paragraphs that follow.

Permeability is the quality that enables a soil to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure porosity and texture. The estimates in table 10 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Soil reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to metals and concrete.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks when dry or swells when wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil properties, such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosion of concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A rating of low indicates a low probability of soil-induced corrosion damage. A rating of *high* indicates a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Erosion factors "K" and "T" are measures of the susceptibility of a soil to partial detachment and transport by rainfall and soil loss (fig. 15).

Soil and water features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to subsidence and frost action of each soil are indicated in table 11. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table, by the presence of bedrock or a cemented pan in the upper 5 or 6 feet of the soil, by subsidence, or by frost action.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil are depth to a water table after prolonged wetting, water intake rate and permeability after prolonged wetting, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency and duration of flooding and the period of the year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Classification of the Soils."

The generalized description of flood hazards is of value in land use planning and provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick in soils for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, whether perched, artesian, or the upper part of the ground water table; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, limited range in depth to bedrock is a part of the definition of the soil series. The depth shown is based on measurements made in many soil borings and other observations during the soil mapping. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200 horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soils, which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfill. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 12 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfill.

If the degree of soil limitation is *slight,* soils are favorable for the specified use and limitations are minor and are easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special design, or intensive maintenance is required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties -and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in

Figure 15.-Severely eroded unprotected area of Hood loam, 3 to 8 percent slopes.

downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and as a result ground water supplies in the area may be contaminated.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. Aerobic lagoons generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. In both types the waste is spread, compacted, and covered daily with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for landfill purposes. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread.

Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate ground water. Soil wetness may be a limitation because of difficulty in operating heavy equipment. Seepage into the refuse increases the risk of pollution of ground water.

In the trench type of landfill, ease of excavation also affects the suitability of a soil for this purpose. Thus, the soil must be deep to bedrock and free of large stones and boulders. In areas where the seasonal water table is high, water seeps into trenches and causes problems in filling.

Unless otherwise stated, the ratings in table 12 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfill should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, the thickness of suitable soil material available and the depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 13. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table, the texture and consistence of soils, the tendency of soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 13 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 13 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action indicate the traffic supporting capacity. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Construction materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 14 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet, and is described as the survey is made.

Roadfill is soil material used in embankments for roads. Soils are evaluated as sources of road fill for low embankments, generally less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 9 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

Soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, high potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*, regardless of the quality of the suitable material.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 14 show that the soils in the Hood River County Area are not suitable as a source of sand and gravel.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slopes, and stone content. The ability of the soil to sustain plant growth is determined by texture, structure, and the amount of soluble salts or toxic substances. The presence of organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, careful preservation and use of material from these horizons is desirable.

Soils rated *good* have at least 16 inches of friable loamy material at the surface. They are free of stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are low in soluble salts that can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable content of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large content of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 15 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and is of favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for. drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing, vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for waterways are slope, permeability, erodibility, and suitability for permanent vegetation.

Formation, Morphology, and Classification of the Soils

This part of the survey defines the factors of soil formation, explains how these factors have affected the soils in the Hood River County Area, and describes important morphological features. It also classifies the soils in the survey area according to the current system of classification.

Formation of Soils

Soil forms through weathering and other processes that act on the parent material. The characteristics of the soil at any given point depend on the parent material, climate, plants and animals, relief, and time.

The active forces that gradually form a soil from

parent material are climate and plant and animal life. Relief strongly influences natural drainage, aeration, runoff, erosion, and exposure to sun and wind. It therefore influences the effectiveness of the active soil-forming processes. Generally, soil-forming factors are complex. Each force interacts with others, slowly but constantly. A soil passes slowly through stages that can be considered as youth, maturity, and old age. The character and thickness of a soil, therefore, depend on the intensity of the soil-forming processes, the length of time during which the various processes have acted, and the resistance of the parent material to change.

At any stage a soil can be affected by mechanical agencies and use by man. The surface layer may be wholly or partly removed by erosion and the material beneath exposed. The soil-making forces then begin working on the exposed material to form a new surface layer. Whether or not erosion benefits the growth of plants depends on the rate of erosion and on the supply of plant nutrients available in the new surface layer. Normal geologic erosion can benefit the soil; accelerated erosion caused by improper use of the land can severely limit the use of the land for many years. Grading, shaping, and leveling of land by man rearrange the soil horizons and interrupt the effects of soil-forming factors. Irrigating a soil when it normally is dry has the effect of placing the soil in a different climatic zone. Draining by ditch or tile drains counteracts the effects of relief and climate, thereby changing the relationship among the soil-forming factors. Applying amendments and chemicals affects the chemical composition of the soil and the plant and animal life.

The five soil-forming factors are defined in the paragraphs that follow.

Parent material

The soils of the Hood River County Area formed in material weathered from bedrock and local movement on sloping uplands and plateaus; material transported by water and laid down in varying proportions as unconsolidated deposits of clay, silt, sand and gravel; pumice from geologically recent volcanic explosions; and silty material transported by wind. Soils forming in residuum and colluvium contain minerals and weathered products of minerals that are similar to those of the original rock. Because alluvial and eolian materials are of mixed origin, the original mineralogy is no longer distinct.

The size of particles and the mineralogy and thickness of the parent material greatly influence the nature of the soils. Some soil characteristics are inherited directly from the parent material. For example, the material on uplands has produced soils that are stony and generally shallow over bedrock. Soils formed in material on mudflows and terraces generally are somewhat gravelly or cobbly and in places are high in content of pumice. Soils formed in eolian deposits of loess are high in silt.

The Columbia River basalt flow has preserved the major ridges in the eastern and northern parts of the survey area. Such soils as Bald, Bodell, Bindle, and Wyeth formed partly in residuum and colluvium weathered from this lava. The Columbia River basalt is commonly more than 1,000 feet thick.

The Dalles Formation has been deposited over older formations in the eastern part of the survey area. It was built up slowly, as indicated by the many layers of buried soils in the regolith and the intervening thin lava flows. Most of the material is loamy and resists weathering. The Frailey is the only soil in the survey area that formed partly in residuum and colluvium weathered from this material.

During recent geologic times a mantle of loess was laid down over a large part of the survey area. Loess is a sediment, commonly nonstratified and unconsolidated, that has been deposited by the wind. It is dominantly silt-sized particles of feldspar, quartz, calcite, and mica, ordinarily with accessory clay and sand. Typically, loess is very smooth and floury.

The loess probably originated from glacial outwash left in the present channel of the Columbia River during the ice age, or Pleistocene Epoch. The loess probably accumulated during warm periods, during the melting of glaciers when the sedimentation of outwash was at a maximum and the ground surface was neither frozen nor blanketed with snow. Winds from the northeast, blowing across the bare outwash, evidently started sand grains moving in a jumping motion. The jumping grains bombarded the surface and kicked silt particles into the air stream. The silt and finer textured sand particles were carried toward the southwest and gradually settled over a wide area. Most soils of the area have been influenced to some extent by loess.

At one or more times during the deposition of the loess, windborne volcanic ash also was deposited in the survey area. Most likely it came from the now extinct volcanoes of the Cascade Mountains. All of the soils in the survey area probably contain some volcanic ash, which consists of sharp-edged, sand-sized to silt-sized particles of silica, feldspar, glass, and other material. The Bins, Bindle, Divers, Ketchly, Wamic variant and Yallani soils formed in material high in volcanic ash. Hutson and Parkdale soils formed almost entirely in volcanic ash.

Climate

The Hood River County Area can be divided into two distinct climatological divisions. The Upper Hood River Valley has heavy annual total precipitation, substantial snowfalls almost every winter, and cool summer temperatures. The Lower Hood River Valley has less precipitation, less snowfall, and significantly warmer temperatures than the upper valley. Representative soils in the upper valley are Divers, Hutson, Parkdale, and Yallani. In the lower valley are Hood, Oak Grove, Rockford, Van Horn, and Wind River soils.

The effects of climate are expressed directly in soil formation and indirectly through the control of the kinds and amount of native vegetation. In the upper valley, temperature in winter is so low that most soils are frozen for long periods. During these periods many processes of soil formation are completely stopped. Average annual air temperature is normally 45° to 52° F. at low elevations and decreases to less than 45° at higher elevations. The upper few inches of the soil is frozen for some period during winter, and daily freezing and thawing are common on south-facing slopes. Summer temperatures are cool.

The total precipitation and season of distribution are such that soils of the lower valley areas become thoroughly dry in some part of the solum for at least 60 days in most years. Soils in the upper valley are usually moist and are dry for less than 45 consecutive days. Average annual precipitation is 25 to 30 inches in the lower valley and eastern part of the survey area, and ranges to about 50 to 90 inches in the conifer forests at the higher elevation. Most of the precipitation falls during the period October to June. Frequent to continuous leaching of soluble material from the soil, and movement of less soluble and suspended material downward in the soil profile are common during these months. The soil is generally leached to a greater depth than those soils that formed in regions where more of the precipitation occurs in summer.

In places the rocks have been weathered to depths of 40 to 60 inches or more. Rocks more resistant to weathering, or of younger age, have not weathered so deeply.

Climate, especially precipitation, has strongly influenced the vegetation. In the valleys and lower elevations in the northeastern part of the survey area, Oregon white oak and ponderosa pine are the dominant trees, and the understory is bunchgrasses and low shrubs. At the higher elevations where the amount of precipitation is greater and temperatures are cooler, the dominant trees are Douglas-fir, grand fir, and bigleaf maple, and there is a dense stand of intermediate and low-growing shrubs. In the area of greatest precipitation and coolest temperatures, western hemlock, noble fir, white pine, and low-growing shrubs, such as rhododendron and huckleberry, are dominant.

More data about the climate is provided in the section "Climate."

Organisms

Plants, animals, micro-organisms, earthworms, and other forms of life that live on and in the soil are active in the soil-forming process. The changes they bring about depend mainly on the kind of life processes peculiar to each. The kinds of plants and animals are determined by such features as climate, parent material, relief, drainage, and age of the soil.

Plants affect soil formation chiefly by influencing the kind, amount, and depth distribution of organic material added to the soil; the circulation of nutrients; and the degree of protection furnished the soil surface. Trees, shrubs, and grass add organic matter to the soil in the form of leaves, twigs, roots, and entire plants. Most of this material accumulates on the surface, where it is acted on by micro-organisms, earthworms, and animals, and by chemical reactions brought about by the effect of climate. Decayed material is washed into the surface layer by percolation of water. It darkens the soil by staining soil peds and helps develop a favorable soil structure. The amount of organic matter in the surface layer is a balance between additions, mainly by plants, and losses resulting from oxidation and microbical decomposition. As nutrients are released by the decay of organic material, they are reused by the plants in their natural cycle of living and dying. The need for plants that are efficient foragers for these nutrients is particularly important in areas where soils are subject to a high leaching potential. Where rainfall is high, nutrients that are not used by plant roots can be leached out of the root zone.

Most of the soils of the Hood River County Area formed under a dense growth of trees, shrubs, and grasses. Thus, the surface layer is 6 to 12 inches thick and has moderate grades of structure. Soils that formed in young parent material along streams have accumulated the least amount of organic matter.

Earthworms, insects, moles, and other animals that live in the soil retard soil formation by remixing the soil material. Clearing, cultivating, introducing new plants, irrigating, and artificial drainage affect the accumulation and decomposition of organic matter. The apparent results of these activities by man are accelerated erosion and alteration of the surface layer. Application of fertilizers and fumigants affects microbical activities and plant-nutrient balance.

Relief

Relief has an important effect on soil formation in the Hood River County Area. It is strongly related to the origin of parent material. Generally, soils that formed in alluvium are on nearly level to gently sloping surfaces, and those formed in colluvium and residuum from rock are on hillsides.

Aspect, or the direction a slope faces, is an important feature of relief that has affected soil formation in this survey area. Soils that have south-facing slopes are warmer and drier than those that have north-facing slopes, have less natural vegetation, a lower content of organic matter, and retain a thinner mantle of loess and volcanic ash against erosion.

Another important feature is slope gradient. The penetration of water decreases and the amount of runoff increases with increasing slope. Slope strongly affects the susceptibility of a soil to water erosion or to downslope movement. Steep soils commonly have thinner and less distinct soil horizons than gently sloping soils.

Most soils in the Hood River County Area are well drained. The wetter Dee and Wyeast soils occur mainly on nearly level terraces in depressions.

Time

The length of time the parent material has been in place and exposed to the active forces of climate and vegetation is an important factor in soil formation. The age of a soil, however, refers to its degree of profile development and is influenced by other factors as well as time. A mature soil has well defined, genetically related horizons. An immature soil shows little or no horizonation. In warm,, humid regions that have dense vegetation, such as the lower Hood River valley, less time is needed for a soil to develop a distinct profile than in dry or cold regions that have sparse vegetation.

Because of differences in relief and parent material, soils that have been forming for about the same length of time will not necessarily have reached the same stage of profile development. If the parent rock is weather resistant, profile development is slow. The slumping of soils on hills changes the soil profile by burying and mixing of material. On steep slopes, normal geologic erosion removes soil material almost as soon as it forms. Consequently, no well defined horizons develop in Wyeth soils.

Soils on old terraces show more profile development, but some are forming in stratified parent materials that differ in age. Oak Grove and Hood soils are examples.

Morphology of Soils

A soil is not easily studied in its natural position because only the surface is exposed. In order to see and study a soil, it is necessary to expose a vertical section, or profile. A profile generally consists of several layers, or horizons. In the Hood River County Area the differentiation of horizons is the result of: the accumulation of organic matter in A horizons, the accumulation of silicate clay in B horizons, the base-saturation levels, and the free-iron accumulation. Each of these factors is discussed in the paragraphs that follow.

Accumulation of organic matter in A horizon.-Organic matter has accumulated in the surface layer of all soils in the survey area to form an A1 horizon. The quantities are lowest in the Wamic, Wind River, and Bodell soils and highest in the Hood, Bins, and Culbertson soils. The removal of native vegetation from many soils and the subsequent reduction in organic matter during fieldwork have markedly changed the structure and water-absorbing capacity of the A1 horizon.

Accumulation of silicate clay in B horizon.-Laboratory data on the content of clay show that Hood and Oak Grove soils have argillic horizons. The Ketchly and Van Horn soils also have argillic horizons, but no data are available on these soils. Argillic horizons are the results of the translocation of silicate clay minerals, a greater formation of clay from primary minerals within the B horizon than within other horizons, or buried layers of older soils.

Base-saturation levels.-The leaching of cations is common in all but the soils in the driest areas and the most recent soils along major streams. The most extreme leaching has occurred in the Hutson, Divers, and Yallani soils. Those soils have high permeability, good drainage, and are subject to high rainfall. Recent alluvial soils have relatively uniform base levels because they are young and receive continuing additions of fresh alluvium during overflow.

Accumulation of free iron.-The weathering of iron-bearing minerals to form ferric oxide and the accumulation of ferric oxides over a long period yield a large concentration of iron in a soil. Ferric oxide is insoluble, or very nearly insoluble, in water. The concentration of ferric oxides is responsible for the reddish color in soils such as Oak Grove and Bins. Soils derived from parent material that is very high in iron-rich weatherable minerals, for example, Bald soils, which formed over basalt, become reddish colored at an earlier age than soils derived from parent material that is low in weatherable iron material, such as Frailey soils, which formed over sandstone. Concretions, or "shot," of iron oxide are common in the surface horizon of some soils in the area. Bins, Parkdale, and Oak Grove soils are examples.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 16, the soil series of Hood River County Area are classified in three categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic grouping of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is identified by a word of three or four syllables ending in sol (Ent-i-sol).

SUBORDER. Each order is divided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. Each suborder is identified by a word of two syllables. The last syllable indicates the order. An example is *Aquept (Aqu*, meaning water or wet, and *ept*, from Inceptisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark colored surface horizons. The features considered are the self-mulching properties of clay, the soil temperature, the major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the dark red and dark brown colors associated with basic rocks.

See Soil Taxonomy, a basic system of soil classification for making and interpreting soil surveys. 330 pp., illus. 1973.

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Each great group is identified by a word of three or four syllables. A prefix is added to the name of the suborder. An example is *Haplaquolls (Hapl,* meaning simple horizons, *aqu* for wetness or water, and *oll*, from Mollisols).

SUBGROUP. Each great group is divided into subgroups, one representing the central (typic) segment of the group, and others called intergrades, which have properties of the group and also one or more properties of another great group, suborder, or order. The subgroup is identified by the name of the great group preceded by one or more adjectives. An example is Typic Xerumbrepts (A typical Xerumbrept)

FAMILY. Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, temperature, permeability, thickness of horizons, and consistence. A family is identified by the name of the subgroup preceded by a series of adjectives. The adjectives are the class names for texture and mineralogy, for example, that are used as family differentiae (see table 16) . An example is the coarse loamy, mixed, mesic family of Typic Xerumbrepts.

Laboratory Data

Physical and chemical characteristics of some representative soils in the Hood River County Area are listed in table 17. The procedures used in making the analyses are described in Soil Survey Investigations Report No. 1 (10).

In preparation for laboratory analysis, soil samples were collected from pits. After air drying, the samples were crushed and passed through a 2-millimeter, round-hole screen. The fraction greater than 2 millimeters in diameter is reported as weighted percentage of the total sample. Analyses were made on soil material less than 2 millimeters in diameter. Results are reported on an oven-dry basis.

The particle-size distribution was determined by the pipette method. Water held at 15 atmospheres tension was measured on the fragmented sieved soil material in a pressure membrane apparatus. Reaction, expressed as pH value, was analyzed by a glass electrode and a mixture of 1 part soil to 1 part water and a mixture of 1 part soil and 1 part KC1 salt solution. Organic carbon is by the Walkley-Black method. Total nitrogen is by the Kjeldah method.

Extractable iron was reduced and extracted by sodium dithionite and the extract was titrated with potassium dichromate.

Extractable cations were leached with 1 N NH4OAc. Extractable sodium and potassium were determined by flame photometry; calcium by permanganate titration; and magnesium gravimetrically as pyrophosphate. Extractable hydrogen was determined by the thriethanolaminebarium chloride method. Cation-exchange capacity (NaOAc) was determined after the sample had been sodium saturated. The exchangeable sodium that was extracted by ammonium acetate represents the cation-exchange capacity of the soil. The percent base saturation was determined by dividing the sum of the extractable bases by the exchange capacity and then multiplying the result of one hundred.

Following are profile descriptions of the soils selected in table 17.

Profile No. 1-Hood loam (S61-Ore-14-3-1 through 8), 180 feet west and 360 feet north of section corner in SE1/4SE1/4SE1/4, sec. 15, T. 2 N., R. 10 E.

Ap1-0 to 5 inches; very dark grayish brown (l0YR 3/2) loam, grayish brown (l0YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; plentiful roots; many fine tubular pores; few fine (1 to 2 millimeters) oxide concretions of iron and manganese; pH 6.2; abrupt smooth boundary.

Ap2-5 to 9 inches; dark brown (10YR 3/3) silt loam, brown (l0YR 5/3) dry; weak medium platy structure parting to weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; plentiful roots; many fine tubular pores; common fine (1 to 2 millimeters) oxide concretions of iron and manganese; pH 6.2; clear smooth boundary.

B11-9 to 18 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium subangular

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blocky structure; slightly hard, friable, slightly sticky and slightly plastic; plentiful roots; many fine tubular pores; pH 6.4; clear smooth boundary.

B12-18 to 32 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to moderate medium subangular blocky structure; slightly hard to hard, friable, slightly sticky and slightly plastic; plentiful roots; many fine tubular pores; thin clay films on some peds and thick clay films in some pores; one rounded quartzite pebble 1 ½ inches in diameter at about 24 inches; pH 6.6; clear wavy boundary.

B21t-32 to 40 inches; dark brown (l0YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky structure; hard, firm, slightly brittle, slightly sticky and slightly plastic; common roots; many fine tubular pores; thin clay films on many peds and in very few pores; common 1 to 5 millimeters manganese dioxide stains; few light brownish gray coatings of clean sand grains in places on prisms; pH 6.2; gradual wavy boundary.

B22t-40 to 57 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (l0YR 5/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky structure; hard, friable to firm, slightly brittle, slightly sticky and slightly plastic; few roots; many fine tubular pores; few thin clay films on peds; few strong brown iron oxide concretions and few black 1 to 4 millimeter manganese dioxide concretions; few spots of light brownish gray clean sand grains on prisms; pH 6.4; clear wavy boundary.

B3t-57 to 72 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (l0YR 5.4/4) dry; weak coarse prismatic structure; hard to very hard, friable to firm, slightly brittle, slightly sticky and slightly plastic; few roots; many fine tubular pores; thick clay films in some pores; few strong brown iron oxide mottles; some 1 to 4 millimeter manganese dioxide stains; thick coatings of light brownish gray, clean sand grains on some prisms; pH 6.5 ; clear wavy boundary.

C-72 to 97 inches; dark brown (l0YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure; hard to slightly hard, friable, slightly sticky and slightly plastic; very few roots; many fine tubular pores; moderately thick clay films in a few pores; few 1 to 5 millimeter spots of grayish brown clean sand grains; some mica flakes; pH 6.5.

Profile No. 2-Hood loam (S61 Ore-14-4-1 through 8), 440 feet east and 430 feet north of south quarter corner in SWl/4SW1/4SE1/4 sec. 13, T. 2 N., R. 10 E. This profile is described on page 15.

Profile No. 3-Oak Grove loam (S61 Ore-14-5-1 through 7) 375 feet west and 165 feet north of east quarter corner in SE1/4SE1/4NE1/4, sec. 17, T. 2 N., R. 10 E.

Ap-0 to 6 inches; dark brown (7.5YR 2.6/2) loam, brown (7.5YR 5/3) dry; weak medium and thick platy structure parting to weak fine granular structure; slightly hard to hard, friable, slightly sticky and slightly plastic; plentiful roots; many fine tubular pores; many 1 to 3 millimeter oxide concretions of iron and manganese; pH 6.2; abrupt wavy boundary.

A3-6 to 14 inches; dark reddish brown (5YR 3/3) heavy loam, reddish brown (5YR 5/4) dry; weak fine subangular blocky structure; slightly hard to hard, friable, slightly sticky and slightly plastic; plentiful roots; many fine tubular pores; few thin clay films on peds and in very few pores; common 1 to 3 millimeter oxide concretions of iron and manganese; pH 6.2; clear wavy boundary.

B11-14 to 29 inches; brown boundary. 4/3) loam, (5YR 5/4) dry; moderate to weak medium sub-

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angular blocky structure; slightly hard to hard, friable, sticky and plastic; plentiful roots; many fine and few medium tubular pores; patchy thin clay films on peds and in few pores; few 1 to 2 millimeter oxide concretions of iron and manganese; pH 6.0; gradual smooth boundary.

B12-29 to 39 inches; dark reddish brown (5YR 3/4) clay loam, reddish brown (5YR 5/4) dry; weak coarse prismatic breaking to moderate medium subangular and angular blocky structure; hard, firm, very sticky and very plastic; plentiful roots; many fine and common medium tubular pores; patchy thin clay films on blocks and moderately thick clay films in some pores; few 1 to 3 millimeter oxide concretions of iron and manganese; common 1 to 10 millimeter stains of manganese dioxide; pH 6.2; gradual smooth boundary.

B21t-39 to 56 inches; color, texture, structure, concretions, stains, roots, pores, and reaction similar to horizon above; hard, firm (firmer than any other horizon of profile), very sticky and very plastic; patchy thick clay films on peds and in some pores; diffuse smooth boundary.

B22t-56 to 83 inches; dark reddish brown (5YR 3/4) clay loam, reddish brown (5YR 5/4) dry; weak coarse prismatic breaking to moderate medium subangular blocky structure; hard to very hard, firm, very sticky and very plastic; few roots; many fine and common medium tubular pores; many thick clay films on peds, and thick clay films in some pores; common 1 to 10 millimeter manganese dioxide stains; pH 6.2; gradual smooth boundary.

B3-83 to 95 inches; reddish brown (5YR 3.6/4) clay loam, (5YR 5/4) dry; moderate medium subangular blocky structure; very hard to hard, firm, very sticky and very plastic; very few roots; many fine and common medium tubular pores; patchy thick dark reddish brown clay films on peds and in pores; very few 1 to 2 millimeter manganese dioxide stains; pH 6.0.

Profile No. 4-Oak Grove loam (S61 Ore-14-6-1 through 8) 65 feet east and 415 feet north of quarter corner in SW1/4SW1/4NW1/4 sec. 9, T. 2 N., R. 10 E. This profile is described on page 18.

Profile No. 5-Parkdale loam (S61 Ore-14-9-1 through 7) 1,370 feet south of sec. line, 100 feet west of the road in NE1/4SE1/4NW1/4 sec. 32, T. 1 N., R. 10 E.

Ap1-0 to 5 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; abundant roots; pores mainly interstitial; common 2 millimeter or less concretions; pH 6.6; clear smooth boundary.

Ap2-5 to 9 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; abundant roots; pores mainly interstitial; concretions as in horizon above; pH 6.0; abrupt wavy boundary.

B2-9 to 18 inches; brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; massive or weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; abundant fine roots; pores mainly interstitial; no clay films; few concretions similar to first horizon; pH 6.2; clear wavy boundary.

C1-18 to 27 inches; brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; massive or weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; plentiful roots; many very fine and fine interstitial pores; no clay films; few concretions as in horizon above; very few nodules of soil material ¼ to 1 inch diameter; pH 6.4; clear wavy boundary.

C2-27 to 46 inches; yellowish brown (l0YR 5/4) silt loam, very pale brown (l0YR 7/4) dry; massive; soft, very friable, nonsticky and slightly plastic;

plentiful roots; pores as in horizon above; no clay films; very few fine concretions; few firm nodules of soil material 1/4 to 1 inch diameter; pH 6.4; gradual wavy boundary.

C3-46 to 74 inches; yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; massive; soft, very friable, nonsticky and slightly plastic; plentiful roots; many very fine and fine interstitial pores; nodules and concretions as in horizon above; pH 6.4; diffuse wavy boundary.

C4-74 to 110 inches; yellowish brown (10YR 5/4) sandy loam, very pale brown (10YR 7/4) dry; massive; slightly hard, firm to friable, slightly brittle, nonsticky and slightly plastic; plentiful roots; pores as in horizon above; very few concretions; common firm nodules 1/4 to 1 inch in diameter; some white porous pumice particles of coarse or medium sand size; pH 6.5.

Profile No. 6-Parkdale loam (S61 Ore-14-10-1 through 7) 130 feet west and 50 feet south of quarter corner in NE1/4NE1/4SE1/4, sec. 6, T. 1 S., R. 10 E. This profile is described on page 19.

Profile No. 7-Wind River sandy loam (S61 Ore-147-1 through 7) 890 feet west and 790 feet north of section corner in NW1/4SE1/4SE1/4, sec. 2, T. 2 N., R. 10 E.

Ap1-0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; abundant roots; pores mainly interstitial; pH 6.3; clear smooth boundary.

Ap2-4 to 9 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; weak fine granular structure; soft to slightly hard, very friable, nonsticky and nonplastic; plentiful roots; pores mainly interstitial; pH 6.1; clear smooth boundary.

B2-9 to 20 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and non plastic; common roots; pores mainly interstitial; few hard rounded masses 1/4 to 3/4 inch in diameter, slightly harder than matrix; pH 6.2; gradual smooth boundary.

C1-20 to 35 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; common roots; many interstitial pores; common hard rounded masses ¼ to ¾ inch in diameter; pH 6.3; gradual smooth boundary.

C2-35 to 58 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; single grain; loose, very friable, nonsticky and nonplastic; common roots in upper part few in lower part; common fine interstitial pores; common hard rounded masses ¼ to 1 1/2 inches in diameter; pH 6.5; gradual smooth boundary.

IIC3-58 to 75 inches; dark yellowish brown (10YR 4/4) loamy sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; very few roots; pores mainly interstitial; thin 1/8 inch wide strong brown horizontal iron band; pH 6.5; clear smooth boundary.

IIIC4-75 to 91 inches; brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain; massive; loose, nonsticky and nonplastic; no roots; pores mainly interstitial; pH 6.6; abrupt smooth boundary.

IVC5-91 to 120 inches; this horizon not sampled. Brown (10YR 4/3) to gray (10YR 5/1) stratified, mainly medium sand, fine sandy loam and very fine sandy loam; massive; loose to very friable, nonsticky to slightly sticky and nonplastic to slightly plastic; no roots; pH 6.5.

Profile No. 8-Wind River fine sandy loam (S61 Ore-14-8-1 through 7) 1,860 feet east and 960 feet north of section corner in NE1/4SE1/4SW1/4, sec. 36, T. 3 N., R. 10 E. This profile is described on page 24.

Profile No. 9-Wyeast silt loam (S61 Ore-14-1 through 9) 155 feet south and 555 feet west of the north quarter corner in NE1/4NE1/4NW1/4, sec. 27, T. 2 N., R. 10 E.

Ap1-0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5.4/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; few 1 to 3 millimeter manganese dioxide concretions; pH 6.2; abrupt smooth boundary.

Ap2-5 to 10 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure, parting to weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; abundant roots but fewer than in Apl horizon; common fine and medium tubular pores; common fine reddish brown mottles; few 1 to 4 millimeter oxide concretions of iron and manganese; pH 6.3; abrupt wavy boundary.

B21-10 to 24 inches; brown (10YR 5/3) silt loam pale brown (10YR 6/3) dry; common fine strong Crown mottles, weak coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine roots; many fine tubular pores; common 1 to 4 millimeter oxide concretions and stains of iron and manganese; pH 6.4; clear smooth boundary.

B22-24 to 38 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common fine strong brown and reddish brown iron oxide mottles weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots mainly along prism faces; many fine and few medium tubular pores; few 1 to 4 millimeter manganese dioxide concretions; bleached clean sand grains on prisms; pH 6.2; abrupt irregular boundary.

IIB21x-38 to 44 inches; dark brown (10YR 4/3) heavy silt loam, light yellowish brown (10YR 6/4) dry; weak coarse prismatic and moderate to weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic brittle, crushing suddenly but less so than in horizons' below; few roots; many fine and common medium tubular pores; many thick dark brown clay films on peds and in pores; some clean bleached light gray very fine sand grains on peds; many manganese oxide stains on peds, pH 6.6; clear wavy boundary.

IIB22x-44 to 50 inches; dark brown l0YR 4/3) heavy silt loam fragipan, light yellowish brown (10YR 6/4) dry; weak coarse prismatic and weak to moderate thick platy structure; hard to very firm, brittle, slightly sticky and slightly plastic; few roots; many fine and few medium tubular pores; many thin clay films on peds and thick dark brown clay films in many pores; some clean bleached sand grains on peds; pH 6.5; clear wavy boundary.

IIB31x-50 to 60 inches; dark brown (10YR 4/3) silt loam fragipan, light yellowish brown (10YR 6/4) dry ; few grayish brown (10YR 5/2) mottles on peds, weak coarse prismatic structure; firm, brittle, crushing suddenly, slightly sticky and slightly plastic; few roots; many fine and few medium tubular pores; thick clay films in pores and on some peds; pH 6.6. This horizon split from next lower horizon for sampling purposes.

IIB32x-60 to 73 inches; this horizon similar to horizon above except for few and thinner clay films, slightly less clay, and few roots; gradual wavy boundary.

IICx-73 to 86 inches; dark brown (10YR 4/3) with few grayish brown spots silt loam estimated 15 percent clay, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable but crushing suddenly, slightly sticky and slightly plastic very few roots; many fine tubular pores; thin clay films in few pores; pH 6.8.

Climate

The Hood River County Area has two fairly distinct climates: the Upper Hood River Valley with its relatively heavy annual total precipitation, substantial snowfall practically every winter, and significantly cooler summer temperatures than in the lower valley; and the Lower Hood River Valley with less precipitation, much less snowfall, and warmer temperatures. Records from two stations were used in evaluating the temperature and precipitation data in the tables that follow-the Parkdale Station, representing the Upper Hood River Valley, and the Hood River Experiment Station, the Lower Valley.

Temperature.-Marine air moving up through the Columbia Gorge and spreading out into the inland Columbia Basin has a moderating effect on the extreme temperatures in both summer and winter. The occasional low winter temperatures that occur are the result of strong invasions of very cold continental air from the northeast. The excessively warm temperatures in summer are similarly the result of an occasional high pressure cell stagnating over the inland Columbia Basin or the Great Basin. This stagnating high pressure cell, blocking out the normal movement of marine air from the west, sets up an east wind through the Columbia Gorge that occasionally extends all the way to the Pacific Ocean.

In most years temperatures will be no higher than 99° F and no lower than about 10° in the Lower Hood River Valley and no higher than 96° and no lower than zero in the Upper Hood River Valley.

Table 18 shows temperature data based on records kept at the Hood River Experiment Station and the Parkdale Station.

Table 19 shows probable dates of the last freezing temperature in spring and the first in fall. These dates are considered significant in the production of. various crops. The number of days between the average last date of a 32° temperature or lower in spring and the first in fall is referred to as the growing season.

The maturity of many crops is closely associated with the accumulation of growing degree days during the growing season. The number of growing degree days is calculated on the average mean temperature for the day minus a specified base temperature. The remainder is the number of growing degree days for that day. As an example, assume a maximum temperature of 64°, a minimum of 38°, and a base temperature of 40°. The mean temperature is 51°. The difference between the 51° mean temperature and the 40° base is 11, or the number of growing degree days for that day. Table 20 lists for each month the average number of growing degree days, for specified base temperatures, in the upper and lower valleys.

Precipitation.-The average annual precipitation ranges from about 25 inches at the east edge of the survey area to about 90 inches on the higher slopes of the Hood River Valley. Between 70 and 80 percent of the precipitation falls in November through March, and only 5 to 10 percent in June through August. The rest is fairly evenly divided between the April-May period and that of September-October. Most of this precipitation is rain, but substantial snowfall occurs almost every winter in the higher reaches of the Hood River Valley. At Parkdale, the recorded seasonal snowfall has ranged from 20 to 222 inches. Measurable precipitation can be expected on approximately 125 days each year in the Lower Hood River Valley and on 145 days in the upper valley.

Table 21 is a summary of certain monthly and annual precipitation data.

Sunshine and cloudiness.-Limited observations in the survey area indicate about 100 to 120 clear days each year, 80 to 90 partly cloudy days, and 165 to 185 cloudy days. No records on the duration of sunshine are available. From analysis of available records of cloudiness in and surrounding the area surveyed, however, it is estimated that the sun shines about 20 to 30 percent of the time possible in December and January; 55 to 65 percent in April, May, and June; and 75 to 85 percent in July, August, and early in September. The

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All tables have been updated and are available as a separate document.

By **GILBERT L. STEVENS,** ESSA State climatologist.

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percentage then gradually decreases to the winter average.

Relative humidity.-Relative humidity of 90 to 100 percent occurs occasionally in summer in the early morning hours, when the air temperature is lowest, and frequently at any time of the day late in fall and in winter. In contrast, during the warmest part of the day in summer, relative humidity between 10 and 12 percent, and occasionally even lower, is not unusual. The average value is 35 percent.

Water Supply

Investigations by the Oregon State Water Resources Board show that the Hood Basin average annual runoff of 1,380,000 acre feet provides far more water than will be needed for potential development within the basin. The average annual water yield from streams and springs supplies irrigation water for 19,000 acres, supplies water for other consumer needs, and allows for about 1,250,000 acre feet of excess surface water, which is sufficient to increase the irrigated acreage by 6,200 acres and still supply additional needs for domestic, municipal, industrial, fish life, and recreational use.

The Hood River County Area has large areas of unappropriated water. At low flow season late in summer, however, irrigation water is limited along the lower parts of a few streams. Storage reservoirs are desirable.

JAMES CRANE, district conservationist, Soil Conservation Service, prepared this section.

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

More than 95 percent of the diverted water in the survey area is used for irrigation. Irrigation development has been restricted by the high cost of developing land and the difficulties in controlling water supplies late in summer. Proposals to irrigate additional lands have not received sufficient public support for project developments. About 95 percent of the land is now

irrigated by sprinklers. Sprinkler irrigation reduces water waste, drainage, and erosion problems. The use of water for hydro-electric power has decreased, and future development is limited.

Seasonal runoff and streamflow are more uniform in the Hood River County Area than in most areas in the state. Heavy snow and rainfall in the high timber areas of the watershed and on the glaciers of Mount Hood supply an abundance of water. Glacial flows are high when irrigation water needs are greatest during hot summers.

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Glossary

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

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

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 60inch profile or to a limiting layer is expressed as-

	Inches
Very low	.0 to 3
Low	3 to 6
Moderate	6to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

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.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well *drained*.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly, restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for Ion g enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainaga results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly

level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

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.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

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

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

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.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.-An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.-The mineral horizon, formed or forming 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.

A2 *horizon.*-A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from, that in the solum the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Illuviation. The accumulation of material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial horizon.

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.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, common, and many; size fine, medium, and coarse; and contrast-faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch; and coarse, more than 15 millimeters (about 0.6 inch).

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

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron zinc and perhaps other elements obtained from the soil; ana carbon, hydrogen, and oxygen obtained largely from the air and water.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called groundwater 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.

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. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine, sand (0.05 millimeter) As a soil textural class, soil that is 80 ;percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by hori-

zontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil depth. The depth of the soil profile. The depth to which the roots of common plants penetrate; the depth to the underlying bedrock, hardpan, or other restrictive layer. The depth classes used in this survey are: shallow 4 to 20 inches; moderately deep 20 to 40 inches; deep over 40 inches.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining 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).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. 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."

Upland (geology). Land at a higher elevation in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water-supplying capacity. Water stored in the soil at the beginning of plant growth in the spring, plus rainfall not in excess of evapotranspiration during the growing season, less runoff.