Foreword

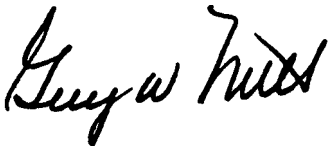
The Soil Survey of Multnomah County, Oregon contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

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

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.



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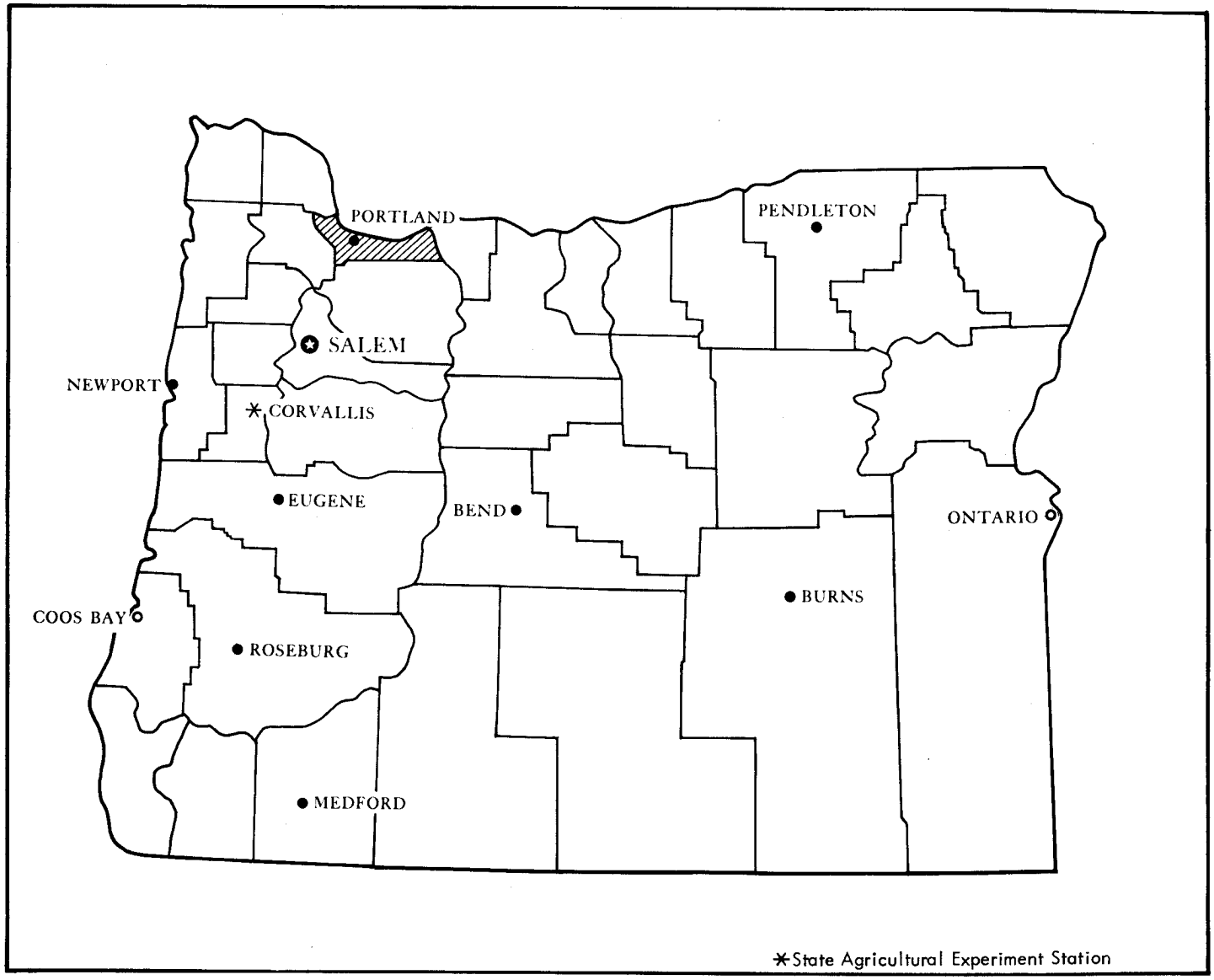

Location of Multnomah County in Oregon.

SOIL SURVEY OF MULTNOMAH COUNTY, OREGON

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United States Department of Agriculture, Soil Conservation Service and
Forest Service, in cooperation with Oregon Agricultural Experiment

MULTNOMAH COUNTY is in the northwestern part of Oregon. This county has a total area of 270,400 acres, or 423 square miles. It is the smallest county in the State. Portland, the largest city, is in the center of the county and has a population of 382,000. Multnomah County is the most urbanized county in Oregon, and among other attributes it is important for truck farming.

Multnomah County is bordered on the north by the Columbia River, except in the northwest a small part is bordered by Columbia County. In general, the county is bordered on the west by Washington County and on the south by Clackamas County. On the east at the crest of the Cascade Mountains, it is bordered by Hood River County.

Multnomah County varies from 6 to 15 miles in width. It is crossed in a north-south direction by the Willamette and Sandy Rivers. The western part of the county consists of rolling hills that have moderate relief and gentle slopes. The eastern part consists of dissected, steeply sloping mountainous areas. The Columbia River is bordered by broad flood plains that grade southward into old terraces. Elevation ranges from about 10 feet along the Columbia River to 4,751 feet on the eastern border.

General nature of the county

This section provides general information concerning the county. It discusses climate; early history; settlement; transportation and markets; physiography; and vegetation. Information in parts of this section is from history of Multnomah County by Robert L. Benson.

Climate

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

The climate of Multnomah County is greatly tempered by winds from the Pacific Ocean. Summers are fairly warm, but hot days are rare. Winters are cool, but snow and freezing temperatures are not common except at higher elevations. During summer, rainfall is extremely light, so crops growing actively during this period need to be irrigated. Commonly, several weeks pass without precipitation. During the rest of the year rains are frequent, especially late in fall and in winter.

Tables 1, 2, 3, and 4 give data on temperature and precipitation for the survey area as recorded at Portland and Bonneville Dam in Multnomah County and Headworks Portland Water Bureau and Government Camp in nearby Clackamas County in the period 1951 to 1976. Tables 5, 6, 7, and 8 show probable dates of the first freeze in fall and the last freeze in spring. Tables 9, 10, 11, and 12 provide data on length of the growing season. Portland, Bonneville, and Headworks, which are at lower elevations, represent the climate in most of the survey area, and Government Camp represents climate on the high mountain slopes in the east.

In winter, the average temperature is about 40 degrees F. in most of the area and the average daily minimum temperature is 34 degrees. The lowest temperature recorded at Bonneville Dam was 0 degrees on December 31, 1968. At high elevations the average winter temperatures are as much as 10 degrees less than the rest of the area. The lowest temperature recorded at Government Camp was-14 degrees on December 17, 1964.

In summer, the average temperature is about 65 degrees F. in most of the area and the average daily maximum temperature is 75 to 78. The highest recorded temperature at Portland was 107 degrees, on July 30, 1965. At high elevations the average summer temperatures are as much as 12 degrees less than the rest of the area although the highest single temperature observed at Government Camp was nearly 100 degrees.

Growing degree days, shown in tables 1, 2, 3, and 4, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to

schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Total annual precipitation is about 40 inches over much of the county, but increases very markedly toward the east to 80 inches or more at both low and high elevations. The heaviest 1-day rainfall during the period of record was 4.73 inches at Bonneville Dam on October 11, 1959. Thunderstorms occur on about 10 days each year, and most occur in summer.

At low elevations average seasonal snowfall at different locations varies, but ranges from about 8 to 18 inches. Greatest snow depth at any one time during the period of record is 8 inches in the west, and 28 inches in the east. There is at least 1 inch of snow on the ground 2 to 6 days a year. At high elevations in the east, total snowfall per year exceeds 200 inches, and the greatest depth exceeds 100 inches. On the average, 100 days have 1 inch or more of snow on the ground.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 75 percent. The percentage of possible sunshine is 60 in summer and 25 in winter. The prevailing wind is from the northwest. Average windspeed is highest, 9 miles per hour, in winter.

In most winters, one or two storms over the whole area bring strong and sometimes damaging winds, and in some years the accompanying heavy rains cause serious flooding. Every few years in winter or summer, a large invasion of continental air mass from the east causes abnormal temperatures. In winter, minimum temperatures on several consecutive days are well below freezing. In summer, maximum daily temperatures for a week or longer are sweltering.

Early history

Multnomah County was established by legislation in 1854. It was formed from parts of Washington and Clackamas Counties. Multnomah County was named after an Indian village that was on the Columbia River side of Sauvie Island, a large delta-type island enclosed by the two final branches of the Willamette River. The village was at Reeder Point, a little south of the present Multnomah-Columbia County line. The basic meaning of Multnomah seems to be "upstream," "up-country," or "in the hinterland."

Several Indian villages and camps were in the survey area. Some of these were noticed by Lewis and Clark or other explorers. Also, there is evidence of prehistoric sites. An example of the latter is the midden called the Woodlawn site, on Columbia slough just north of the Portland district of Woodlawn. The language in Multnomah County was called Kiksht, (or Upper Chinook). It had four dialects; Cathlamet and Wasco dialects were not spoken in Multnomah County, but Clackamas (or Willamette) and Cascades (or Watala) were spoken in the western and eastern parts of Multnomah County respectively.

The Indian villagers were mainly fishermen, and magnificent runs of salmon, returning without fail each spring and fall, made life fairly easy for them. Waterfowl and deer were hunted, and wild bulbs and berries were gathered. The fairly numerous population shrank drastically as a result of epidemics. The malaria epidemic of 1829-30 wiped out several villages.

Settlement

Most early pioneers in the survey area were farmers. They settled first on the rich, flood-free prairies and in the valleys.

Multnomah County did not have great natural prairies to lure the early pioneers as did the Tualatin and Willamette valleys. However, the very rich soil and evergreen meadows on Sauvie Island attracted dairy farmers. Meadowlands all along the Columbia River frontage attracted settlers in spite of the hazard of annual flooding. In many places, the Sandy River country was slightly elevated above the river, and these areas were good for truck farming and gardening, even though clearing was necessary in some places. Also by the use of dikes, many old ponds and meadows were converted to truck farms. On benchlands around Portland and Gresham, small farms were cleared in the woodlands. Clearings were made along the banks of the Willamette River. Each of these clearings marked the headquarters of a claim that extended back into the timber.

During the period 1825-45, Multnomah County remained largely a wilderness. Nathaniel Wyeth built a post, Fort Williams, on the ruins of an Indian village on the Multnomah Channel side of Sauvie Island, but the venture failed.

The first settler in Portland is reported to have been William Johnson, whose cabin on the west bank of the Willamette River overlooked the foot of Ross Island. An early settler, Henderson Luelling, set out an orchard and established a nursery of young trees on the east bank of the river, just north of Milwaukie. This nursery supplied a great deal of the orchard stock to early pioneers in Oregon.

Transportation and markets

Before the British-American boundary settlement of 1846, the Hudson's Bay Company at Vancouver provided a market to farmers for surplus wheat. After the settlement, Fort Vancouver became an American army installation, and the Hudson's Bay Company moved to Victoria. The farmers then exported wheat to markets in Hawaii and other Pacific mission stations. In the late 1840's, Oregon farmers furnished wheat to miners in gold-mining boomtowns of California.

A big problem to the early settlers in exporting wheat was getting the wheat from the fertile farms to dockside. Favorite ports at first were Oregon City and Milwaukie. These ports were far older than Portland, but they were

harder to reach by ship and also harder for grain farmers of the Tualatin plains to reach. Linnton was an older port and far closer to the plains, but traversing the steep mountain behind was difficult. St. Helens had an excellent moorage, but its tributary road was far too long and rough.

At Portland, just below Ross Island, the water was always deep enough for ocean-going ships; consequently, roads for hauling grain and produce to market were constructed. Portland soon became a major center for transportation and markets. Some old grain roads as they are known today are the Palatine Hill, the Taylor's Ferry, the Barnes, the Germantown, the Springville, the Cornelius Pass, and the Plank Road.

The railroad age was preceded and overlapped by an age of river steamboats. Portland was, for a time, the home port of a score of paddle-wheelers which linked Astoria, the Willamette, and the upper Columbia country.

The Northern Pacific reached Portland in 1883 and the Union Pacific reached it in 1884. Rail connection was made with California in 1887.

Portland became the center of a great net of freight lines which still exist. In the early 1920's the interurban system in Portland was one of the most efficient systems in the United States.

Physiography

Bottom lands along the Columbia River and Sauvie Island are separated from the mainland by bayous and sloughs. These bottom lands extend westward from the delta of the Quicksand or Sandy River near Troutdale. During the spring freshet in May and June, followed by the snowmelt from parts of several states and Canada, the bottom lands are subject to flooding. When flooded, the bayous and sloughs become a vast expanse of the Columbia River. This has been a natural occurrence for thousands of years. Modern dams have helped to control the flooding, but occasionally flooding still occurs, as in 1948.

Periods of volcanic activity and catastrophic flooding have occurred in the past in the survey area. The cones remain as picturesque timbered hills dotting the Portland area. A few, including Mt. Tabor and Mt. Sylvania, have unmistakable vents or craters, with cinders.

The catastrophic floodings were related to the several ice ages that came to North America over many thousands of years. Each of these ice ages had a thawing stage of hundreds of years, during which the Kootenay-Flathead trench in Canada and Montana was drowned by a frigid lake of great size. The lake was held in check by a lobe of ice in the gorges of northern Idaho. As the thawing continued the ice dam subsequently gave way. Mighty walls of water moved swiftly across the lowlands of Washington and Oregon. Sullivan's gulch, route of the main railway and highway from the east, is one of the channels gouged out and deepened by these catastrophic floods.

Vegetation

The rainy winters of western Oregon support an unbroken cover of vegetation. In the low riverside country there are a few small prairies and many ponds and swamps. Along the riverbanks grows a lofty fringe of cottonwood trees, as much as 80 feet high. Smaller trees, such as ash, willow, and the native apple, favor the banks of sloughs and marshes. Oak Island, a part of Sauvie Island, has a magnificent stand of Oregon white oak.

Benchlands, safely above the annual floods, support a somewhat stunted growth of Douglas-fir, the dominant tree of western Oregon. These trees are "stunted" only in comparison to trees on better soils in the foothills and mountains. In Forest Park, on the flanks of the Tualatin Mountains; in the Bull Run watershed; and scattered in the Columbia gorge are Douglas-fir at climax that are 4 to 6 feet thick and 200 feet high.

Douglas-fir is far better and stronger timber than the true or balsam firs, although these trees are closely related. To avoid associations with the weak balsam tribe, Douglas-fir was sometimes marketed under the name "Oregon pine." Douglas-fir makes a fine construction wood, scarcely inferior to hardwoods. It captured many American and foreign markets. Much of it was processed in the big mills at Portland and Linnton, and in mills at Bridal Veil and Folkenberg, and elsewhere in Multnomah County. As early as 1851-52, maps indicate that a steam sawmill was in Portland at the foot of Taylor or Salmon Street.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; 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, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photo-

graphs show woodlands, buildings, field borders, roads, 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 soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The soils in the survey area vary widely in their potential for major land uses.

Each map unit is rated for *cultivated farm crops, specialty crops, wood/and, urban uses,* and *recreation areas.* Cultivated farm crops are those grown extensively by farmers in the survey area. Specialty crops include vegetables, fruits, and nursery crops grown on limited acreage and generally requiring intensive management. Woodland refers to land that is producing either trees native to the area or introduced species. Urban uses include residential, commercial, and industrial developments. Intensive recreation areas include campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic. Extensive recreation areas include those used for nature study and as wilderness.

Areas dominated by very deep, excessively drained to very poorly drained, nearly level soils on bottom lands

These soils are on nearly level bottom lands. They are in the northern part of Multnomah County along the Columbia and Willamette Rivers. These soils are in one map unit and make up about 21 percent of the county.

These soils are silt loams, silty clay loams, and sands. They formed in recent alluvium. These soils are generally underlain by coarse or moderately coarse alluvium below a depth of 60 inches. Slopes range from 0 to 15 percent, and elevation ranges from 10 to 20 feet. The average annual precipitation ranges from 40 to 50 inches, and the average annual air temperature ranges from 52 to 54 degrees F. The frost-free period is 165 to 210 days.

1. Sauvie-Rafton-Pilchuck

Excessively drained to very poorly drained silt loams, silty clay loams, and sands

This map unit consists of nearly level to moderately steep soils on bottom lands. In areas not cultivated, the vegetation is Oregon white oak, Oregon ash, Douglas-fir, black cottonwood, willow, roses, common snowberry, trailing blackberry, forbs, grasses, and sedges.

This map unit is made up of about 30 percent Sauvie soils, 10 percent each Pilchuck and Rafton soils, and 50 percent soils of minor extent and Urban land.

The Sauvie soils have a surface layer of very dark grayish brown silt loam and a subsoil of dark grayish

brown, mottled silty clay loam. The substratum is dark grayish brown, mottled silt loam over fine sandy loam to a depth of 60 inches or more.

The Rafton soils have a surface layer of dark grayish brown, mottled silt loam and a subsoil of grayish brown and brown, mottled silt loam. The substratum is dark grayish brown silt loam over black silt loam to a depth of 60 inches or more. These soils are subject to frequent flooding from December to July and in places are subject to ponding into July.

The Pilchuck soils have a surface layer of very dark grayish brown sand. The substratum is dark grayish brown sand to a depth of 60 inches or more. Sandy material dredged from the river channel is in some areas of Pilchuck soils.

Of minor extent in this map unit are the somewhat excessively drained Burlington fine sandy loam, the poorly drained Faloma silt loam, the very poorly drained Moag silty clay loam, and the somewhat excessively drained Sifton gravelly loam soils. The Burlington soil is on long narrow terraces, generally above an elevation of 20 feet. The Faloma soil has a sandy substratum. The Moag soil is in convex areas. The Sifton soil is on terraces, generally above an elevation of 20 feet. Also in this map unit are Urban land, Riverwash, and water areas.

The soils in this map unit are used for farming, urban development (fig. 1), and wildlife habitat. Where the soils are diked and drained, the potential for farming is good and commonly grown crops are suited. In unprotected

Figure 1.-Urban development in an area of Sauvie-Rafton-Pilchuck map unit.

areas, crops and other uses are limited by flooding from December through June. Flooding and wetness are severe limitations for most uses. The potential for residential development is poor. The potential for wildlife habitat is good.

Areas dominated by very deep, well drained to poorly drained, nearly level to moderately steep soils on broad rolling terraces

These nearly level to moderately steep soils are on broad rolling terraces. They are in the central part of the county south of the bottom lands along the Columbia River. These soils are in three map units and make up about 22 percent of the county.

These soils are loams and silt loams. They formed in old alluvial materials. Slopes range from 0 to 60 percent, and elevation ranges from 50 to 400 feet. The average annual precipitation ranges from 40 to 60 inches, and the average annual air temperature ranges from 52 to 54 degrees F. The frost-free period is 165 to 210 days.

2. Quatama-Quafeno-Wollent

Moderately well drained and poorly drained loams and silt loams

This map unit consists of nearly level to moderately steep soils on terraces adjacent to bottom lands along the Columbia and Willamette Rivers. These soils formed in old alluvium. In areas not cultivated, the vegetation is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, grasses, sedges, and forbs. Elevation ranges from 50 to 400 feet. The average annual precipitation ranges from 40 to 60 inches, and the average annual air temperature ranges from 52 to 54 degrees F. The frost-free period is 165 to 210 days.

This map unit makes up about 5 percent of the county. It is about 35 percent Quatama soils, 25 percent Quafeno soils, 15 percent Wollent soils, and 25 percent soils of minor extent and Urban land.

The Quatama soils have a surface layer of dark brown loam and a subsoil of dark yellowish brown loam and clay loam. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

The Quafeno soils have a surface layer of very dark grayish brown loam and a subsoil of dark brown loam and very fine sandy loam. The substratum is brown very fine sandy loam to a depth of 60 inches or more.

The Wollent soils have a surface layer of very dark grayish brown silt loam and a subsoil of gray, mottled silt loam. The substratum is gray silty clay loam to a depth of 60 inches or more. These soils are subject to a seasonal water table above a depth of 12 inches from November to May.

Of minor extent in this map unit are the somewhat poorly drained Aloha silt loam, the well drained Latourell loam, and the somewhat excessively drained Burlington fine sandy loam soils. Also in this map unit are areas of Urban land.

The soils in this map unit are used for farming, urban development, and wildlife habitat. Wetness and moderately slow permeability are the main limitations for most uses. If these soils are drained, the potential for farming and urban development is good. The potential for wildlife habitat is good.

3. Multnomah-Latourell-Urban land

Well drained loams and silt loams

This map unit consists of nearly level to moderately steep soils on terraces adjacent to bottom lands along the Columbia and Willamette Rivers. These soils formed in old alluvium. In areas not cultivated, the vegetation is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs. Elevation ranges from 50 to 400 feet. The average annual precipitation ranges from 40 to 60 inches, and the average annual air temperature ranges from 52 to 54 degrees F. The frost-free period is 165 to 210 days.

This map unit makes up about 15 percent of the county. It is about 35 percent Multnomah soils, 25 percent Latourell soils, 25 percent Urban land, and 15 percent soils of minor extent.

The Multnomah soils have a surface layer of dark brown silt loam. The subsoil is dark yellowish brown gravelly silt loam over very gravelly sand to a depth of 60 inches or more.

The Latourell soils have a surface layer of dark brown and brown loam and a subsoil of dark yellowish brown loam. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

The Urban land areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Of minor extent in this map unit are the somewhat poorly drained Aloha silt loam, the moderately well drained Quatama loam, the poorly drained Wapato silt loam, and the poorly drained Wollent silt loam soils. The Wapato soil is along narrow bottom lands, and the Wollent soil is in concave positions.

The soils in this map unit are used for urban development, farming, and wildlife habitat. The potential is good for most uses. There are no major limitations, however, some uses are limited in areas that have slopes of more than 15 percent. Septic tank absorption fields in areas of Multnomah soils can contaminate ground water sources

because of very rapid permeability in the underlying gravel. The potential for wildlife habitat is good where urban development does not interfere.

4. Powell

Somewhat poorly drained silt loams

This map unit consists of nearly level to moderately steep soils on broad high terraces in the south-central part of the county. These soils formed in silty materials. In areas not cultivated, the vegetation is Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, roses, common snowberry, forbs, and grasses. Elevation ranges from 300 to 600 feet. The average annual precipitation ranges from 50 to 60 inches, and the average annual air temperature ranges from 50 to 54 degrees F. The frost-free period is 165 to 210 days.

This map unit makes up about 2 percent of the county. It is about 90 percent Powell soils and 10 percent soils of minor extent.

The Powell soils have a surface layer of dark brown silt loam and a subsoil of brown, mottled silt loam. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more. Depth to the fragipan is 20 to 30 inches. These soils are subject to a seasonal water table above a depth of 20 inches from December to April.

Of minor extent in this map unit are the poorly drained Wapato and Wollent silt loams. The Wapato soil is along narrow bottom lands, and the Wollent soil is in concave depressions and drainages.

The soils in this map unit are used for farming, urban development, and wildlife habitat. The potential for farming is good if slopes are less than 8 percent. If these soils are drained, most climatically adapted crops do well. The potential for wildlife habitat is good. The main limitations for urban development are somewhat poor drainage, slow permeability, and 20 to 30 inch depth to the fragipan.

Areas dominated by moderately deep to very deep, well drained to somewhat poorly drained, warm, moist soils on uplands

These nearly level to very steep, warm, moist soils on uplands are adjacent to the valley floor in the eastern and western parts of the county. These soils are in five map units and make up about 34 percent of the county.

These soils are loams, silt loams, silty clay loams, and cobbly loams. They formed in volcanic ash and in sediment and colluvium weathered from basalt and andesite. Slopes range from 0 to 90 percent, and elevation ranges from 50 to 2,800 feet. The average annual precipitation ranges from 40 to 100 inches, and the average annual air temperature ranges from 45 to 54 degrees F. The frost-free period is 100 to 210 days.

5. Bull Run-Mershon

Very deep, well drained and moderately well drained silt loams

This map unit consists of nearly level to steep soils on uplands in the eastern part of Multnomah County. These soils formed in silty material mixed with volcanic ash and old alluvium. In areas not cultivated, the vegetation is Douglas-fir, red alder, bigleaf maple, western redcedar, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, Oregon oxalis, swordfern, grasses, and forbs. Elevation ranges from 450 to 1,500 feet. The average annual precipitation ranges from 60 to 100 inches, and the average annual air temperature ranges from 48 to 54 degrees F. The frost-free period is 100 to 200 days.

This map unit makes up about 4 percent of the county. It is about 50 percent Bull Run soils, 35 percent Mershon soils, and 15 percent soils of minor extent.

The Bull Run soils have a surface layer of very dark brown and very dark grayish brown silt loam and a subsoil of dark yellowish brown silt loam. The substratum is dark yellowish brown silt loam to a depth of 60 inches or more.

The Mershon soils have a surface layer of very dark grayish brown silt loam and a subsoil of brown silt loam. The substratum is a dark brown loam to a depth of 60 inches or more.

Of minor extent in this map unit are the well drained Aschoff cobbly loam, the somewhat excessively drained Dabney loamy sand, and Haplumbrepts soils. The Aschoff soil is in steep areas, the Dabney soil is on low terraces along the Sandy River, and the Haplumbrepts are on steep side slopes above the Sandy River.

The soils in this map unit are used mainly for timber production, forage crops, urban development, and wildlife habitat. The potential for forage crops, the production of Douglas-fir, and wildlife habitat is good. These soils have no major limitations for urban uses if slopes are less than 15 percent. Drainage is a concern on the Mershon soils, and in places it restricts some uses. Some urban uses are limited by the wet, cold climate during winter.

6. Cazadero-Haplumbrepts

Deep, well drained and moderately well drained silt loams, loams, and silty clay loams

This map unit consists of nearly level to moderately steep soils on terraces and very steep soils on canyon slopes on uplands in the eastern part of Multnomah County. These soils formed in old alluvium mixed with loess and volcanic ash. In areas not cultivated, the vege-

tation is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar. Elevation ranges from 600 to 1,500 feet. The average annual precipitation ranges from 60 to 90 inches, and the average annual air temperature ranges from 50 to 52 degrees F. The frost-free period is 160 to 200 days.

This map unit makes up about 2 percent of the county. It is about 65 percent Cazadero soils, 20 percent Haplumbrepts, and 15 percent soils of minor extent.

The Cazadero soils have a surface layer of very dark brown silty clay loam. The subsoil is dark reddish brown silty clay loam over reddish brown silty clay to a depth of 60 inches or more.

The Haplumbrepts have a surface layer of very dark brown or dark brown silt loam, loam, or silty clay loam. The subsoil is dark yellowish brown or dark brown silt loam, foam, or silty clay loam and has as much as 65 percent pebbles or cobbles. In places, the substratum is silty, or is sandy and cobbly, or is gravelly. It is very thick.

Of minor extent in this map unit are the well drained Aschoff cobbly loam, the moderately well drained Mershon silt loam, and the somewhat excessively drained Dabney loamy sand soils. The Dabney soil is on low terraces along the Sandy River. Also in this map unit are areas of Riverwash.

The soils in this map unit are used for farming, timber production, urban development, and wildlife habitat. The potential for farming is fair. The soils are better suited to forage crops than to most other crops. They are well suited to timber production. The potential for wildlife habitat is good. The moderately slow permeability of the Cazadero soils and the steep slope of the Haplumbrepts are the main limitations for urban development.

7. Cascade-Urban land-Cornelius

Moderately deep and deep, moderately well drained and somewhat poorly drained silt loams

This map unit consists of nearly level to steep soils on old terraces that are dissected and rolling in the western part of Multnomah County. These soils formed in silty materials. In areas not cultivated, the vegetation is Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, Oregon white oak, willow, creambush oceanspray, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Oregon-grape, roses, swordfern, common snowberry, forbs, and grasses. Elevation ranges from 250 to 1,400 feet. The average annual precipitation ranges from 40 to 70 inches, and the average annual air temperature ranges from 50 to 54 degrees F. The frost-free period is 165 to 210 days.

This map unit makes up about 11 percent of the county. It is about 45 percent Cascade soils, 30 percent Urban land, 10 percent Cornelius soils, and 15 percent soils of minor extent.

The Cascade soils have a surface layer of dark brown silt loam and a subsoil of dark brown silt loam. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more. Depth to the fragipan is 20 to 30 inches.

The Urban land areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

The Cornelius soils have a surface layer of dark brown silt loam and a subsoil of brown silt loam over silty clay loam. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more. Depth to the fragipan is 30 to 40 inches.

Of minor extent in this map unit are the poorly drained Delena silt loam, the moderately well drained Goble silt loam, the moderately well drained Helvetia silt loam, and the well drained Saum silt loam soils. The Delena soil is on concave slopes, the Goble soil is on uplands, the Helvetia soil is on convex slopes on old terraces, and the Saum soil is on low hills.

The soils in this map unit are used for farming, timber production, urban development, and wildlife habitat. If these soils are drained, most commonly grown crops are suited. The potential for farming is good in areas that have slopes of less than 8 percent. The potential for timber production and wildlife habitat is good. Urban development is limited by the drainage conditions, slow permeability, and the fragipan. If the soil is drained and slope is not a concern, the potential for most urban uses is good.

8. Goble-Wauld

Very deep and moderately deep, moderately well drained and well drained silt loams and very gravelly loams

This map unit consists of nearly level to very steep soils in mountainous areas along the Columbia River in the western part of Multnomah County. These soils formed in silty materials high in volcanic ash and in residuum and colluvium weathered from basalt. In areas not cultivated, the vegetation is Doulgas-fir, western hemlock, grand fir, western redcedar, red alder, bigleaf maple, red huckleberry, vine maple, western hazel, willow, thimbleberry, Cascade Oregon-grape, trailing blackberry, salal, common snowberry, roses, swordfern, and forbs, including Pacific trillium and violets. Elevation ranges from 200 to 1,600 feet. The average annual precipitation ranges from 60 to 70 inches, and the average annual air temperature ranges from 47 to 52 degrees F. The frost-free period is 100 to 200 days.

This map unit makes up about 8 percent of the county. It is about 70 percent Goble soils, 10 percent Wauld soils, and 20 percent soils of minor extent.

The Goble soils have a surface layer of very dark grayish brown silt loam. The subsoil is dark brown silt loam and silty clay loam in the upper part and is a mottled, dark yellowish brown, silty clay loam fragipan to

a depth of 60 inches or more. Depth to the fragipan is 30 to 48 inches. Slopes are mainly 60 percent or less.

The Wauld soils have a surface layer of very dark brown, very gravelly loam. The subsoil is very dark grayish brown, very gravelly loam over dark brown, very gravelly clay. Depth to basalt bedrock is 20 to 40 inches. Slopes are mainly 30 to 70 percent.

Of minor extent in this map unit are the somewhat poorly drained Cascade silt loam, the poorly drained Delena silt loam, and the moderately well drained Quatama loam soils. The Delena soils are on concave slopes, and the Quatama soils are on low terraces.

The soils in this map unit are used for farming, timber production, urban development, and wildlife habitat. The potential for farming is poor and is limited mainly to forage crops. The potential for timber production and wildlife habitat is good. Urban development is limited by the steeper slopes, and some uses are restricted on the Goble soils by the slowly permeable fragipan.

9. Aschoff-Rock outcrop

Deep, well drained cobbly loams, and Rock outcrop

This map unit consists of moderately steep to very steep soils on canyon slopes in mountainous areas along the Columbia River. These soils are in the eastern part of Multnomah County. They formed in colluvium weathered from basalt and andesite mixed with a small amount of volcanic ash. Vegetation is Douglas-fir, bigleaf maple, red alder, vine maple, western hazel, dogwood, Cascade Oregon-grape, trailing blackberry, salal, common snowberry, roses, and swordfern. At elevations above 1,700 feet and on north-facing slopes, western hemlock and red huckleberry are common. Elevation ranges from 50 to 2,800 feet. The average annual precipitation ranges from 60 to 100 inches, and the average annual air temperature ranges from 45 to 52 degrees F. The frost-free period is 100 to 200 days.

This map unit makes up about 9 percent of the county. It is about 55 percent Aschoff soils, 10 percent Rock outcrop, and 35 percent Rubble land and soils of minor extent.

The Aschoff soils have a surface layer of very dark brown and dark brown cobbly loam and a subsoil of dark brown very cobbly loam. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Rock outcrop consists of almost perpendicular cliffs that are as much as 500 feet in height.

Of minor extent in this map unit are the well drained Bull Run silt loam, the moderately well drained Mershon silt loam, the well drained Wahkeena very cobbly clay loam soils, and the well drained Haplumbrepts. The Haplumbrepts are silt loam, loam, or silty clay loam. Also in this unit is extremely cobbly and stony Rubble land.

The soils in this map unit are used for wildlife habitat, extensive recreation areas, and timber production. The potential for wildlife habitat, recreational development, and timber production is good. Steep slopes are the major limitation for recreational development. Slopes and high content of coarse fragments are major limitations for timber production.

Areas dominated by very deep and deep, well drained, cold, moist soils on uplands

These nearly level to very steep, cold, moist soils are on moist uplands. These soils are in the eastern part of Multnomah County in the Cascade Mountains. They are in three map units and make up about 23 percent of the County.

These soils are gravelly loams, gravelly silt loams, very gravelly silt loams, and very cobbly fine sandy loams. They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. The soils are generally underlain by glacial till or bedrock below a depth of 60 inches. Slopes range from 5 to 90 percent, and elevation ranges from 1,500 to 4,000 feet. The average annual precipitation ranges from 70 to 135 inches, and the average annual air temperature ranges from 40 to 45 degrees F. The frost-free period is 10 to 100 days.

10. Zygore

Deep, well drained gravelly loams

This map unit consists of nearly level to very steep soils in mountainous areas on the western foot slopes of the Cascade Mountains. These soils formed in colluvium and glacial till from basalt and andesite mixed with volcanic ash. Vegetation is western hemlock, Douglas-fir, grand fir, red alder, western redcedar, vine maple, red huckleberry, salal, swordfern, Oregon oxalis, and forbs. Elevation ranges from 1,500 to 3,000 feet. The average annual precipitation ranges from 80 to 100 inches, and the average annual air temperature ranges from 42 to 45 degrees F. The frost-free period is 30 to 100 days.

This map unit makes up about 9 percent of the county. It is about 90 percent Zygore soils and 10 percent soils of minor extent and Rock outcrop.

The Zygore soils have a surface layer of dark brown gravelly loam. The subsoil is dark brown cobbly loam. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Of minor extent in this map unit are the well drained Aschoff cobbly loam soils and areas of soils that are similar to Zygore soils but have bedrock at a depth of 20 to 60 inches. Also in this map unit are areas of Rock outcrop.

The soils in this map unit are used for timber production, wildlife habitat, and water supply. The potential for these uses is good. The high content of coarse fragments is the main limitation for timber production. Most of the potential for wildlife habitat depends on the management of existing plant communities.

11. Kinzel-Divers-Goodlow

Deep and very deep, well drained gravelly silt loams

This map unit consists of nearly level to very steep soils on broad ridgetops of the Cascade Mountains. These soils are in the eastern part of Multnomah County. They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Vegetation is Douglas-fir, western hemlock, noble fir, western redcedar, red alder, vine maple, blue huckleberry, beargrass, and forbs. Elevation ranges from 2,800 to 3,600 feet. The average annual precipitation ranges from 70 to 135 inches, and the average annual temperature ranges from 40 to 45 degrees F. The frost-free period is 10 to 30 days.

This map unit makes up about 12 percent of the survey area. It is about 40 percent Kinzel soils, 20 percent Divers soils, 20 percent Goodlow soils, and 20 percent Rubble land and soils of minor extent.

The Kinzel soils have a surface layer of dark brown, gravelly silt loam and a subsoil of dark brown, very gravelly silt loam. The substratum is brown, very gravelly loam to a depth of 60 inches or more.

The Divers soils have a surface layer of dark brown, gravelly silt loam and a subsoil of brown, gravelly, cobbly, or very cobbly loam. The substratum is dark yellowish brown, very cobbly loam to a depth of 60 inches or more.

The Goodlow soils have a surface layer of dark brown, gravelly silt loam and a subsoil of brown, very cobbly clay loam. The substratum is brown, very cobbly loam to a depth of 60 inches or more.

Of minor extent in this map unit are areas of a well drained very cobbly fine sandy loam that is 20 to 40 inches deep to bedrock, a well drained Talapus very gravelly silt loam, a well drained Lastance stony fine sandy loam, and a well drained Zygore gravelly loam. Also included in this map unit are Rubble land and very poorly drained, organic, nearly level Cryofibrists.

The soils in this map unit are used for timber production, wildlife habitat, and water supply. The potential for these uses is good. The cold soil temperatures in summer, acid soil conditions, and high content of coarse fragments are the main limitations for timber production. Most of the potential for wildlife habitat depends on the management of existing plant communities.

12. Lastance-Talapus

Deep, well drained very gravelly silt loams and very cobbly fine sandy loams

This map unit consists of nearly level to very steep soils on broad ridgetops of the Cascade Mountains. These soils are in the eastern part of Multnomah County (fig. 2). They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Vegetation is noble fir, western hemlock, Douglas-fir, blue huckleberry, rhododendron, beargrass, and forbs. Elevation ranges from 3,300 to 4,000 feet. The average annual precipitation ranges from 90 to 135 inches, and the average annual air temperature is 40 to 45 degrees F. The frost-free period is less than 30 days.

This map unit makes up about 2 percent of the county. It is about 65 percent Lastance soils, 25 percent Talapus soils, and 10 percent soils of minor extent and Rubble land.

The Lastance soils have a surface layer of gray stony fine sandy loam. The subsoil is dusky red over dark brown stony or very cobbly fine sandy loam. The substratum is brown extremely gravelly fine sandy loam to a depth of 60 inches or more.

The Talapus soils have a surface layer of black very gravelly silt loam over very dark brown very gravelly silt loam. The subsoil is dark brown very gravelly loam over dark brown and brown extremely gravelly loam. The substratum is dark reddish brown extremely gravelly loam to a depth of 60 inches or more.

Of minor extent in this map unit are the well drained Kinzel gravelly silt loam soils and soils that are similar to the major soils but have cemented glacial till or bedrock at a depth of 20 to 40 inches. Also of minor extent in this map unit is Rubble land.

This map unit is used for water supply, wildlife habitat, and timber production. The potential for water supply and wildlife habitat is good. Most of the potential for wildlife habitat depends on the management of existing plant communities. The ecosystem is fragile, and recovery from drastic changes is very slow. The potential for timber production is poor. Noble fir is better suited to this map unit than most other trees. The cold soil temperatures in summer, acid soil conditions, and high content of coarse fragments are the main limitations to timber production.

Broad land use considerations

Joan Perry, soil conservationist, Soil Conservation Service, assisted in the preparation of this section.

The use of land for urban development is an important issue in Multnomah County. At present in many areas, land is being used for homesites at a rapid rate. An estimated 64,000 acres, or about 22 percent of the survey area, is urban land or built-up land (fig. 3). In general, the soils that have good potential for cultivated crops also have good potential for urban development.

Soils in the Multnomah-Latourell-Urban land map unit have few limitations for buildings. These soils are rapidly being used for urban development because they are adjacent to the incorporated areas of Portland and are readily accessible. Many soils in this map unit are a good source of sand and gravel, and many areas are being mined for these purposes. Aloha, Quatama, Wapato, and Wollent soils are in this map unit.

Only a few soils in Multnomah County are so unfavorable that their development is not feasible. Examples of

Figure 2.- Nearly level to very steep Lastance and Talapus soils in areas of the Cascade Mountains.

such soils are in parts of the Sauvie-Rafton-Pilchuck map unit that are on flood plains outside the dike and are subject to seasonal flooding and ponding.

Also unfavorable for development are soils in parts of the Lastance-Talapus and Kinzle-Divers-Goodlow map units. These soils are steeply sloping, or are shallow to hard bedrock or cemented glacial till, or have climatic limitations. Also in these map units are Cryofibrists, or cold peat soils, and Rubble land. The Aschoff-Rock outcrop map unit has soils that are limited for development by steep slopes, coarse fragments, and shallow depth to bedrock. Other soils in this map unit are Bull Run, Mershon, Wahkenna, and Haplumbrepts. The Lastance-Talapus, the Kinzle-Divers-Goodlow, and the Aschoff-Rock outcrop map units are mainly in the Mount Hood National Forest. They are commonly used for woodland, wildlife habitat, and water supply.

Soils in the Powell map unit are limited for development by a perched seasonal high water table that restricts drainage. Also, concerns in landscaping are common on these soils if the topsoil is removed and the cemented layer is exposed. Soils in this map unit are highly erodible when exposed by construction or cultivation. Soils in the Powell map unit are successfully used for nursery stock and berries. Subsurface drainage makes earlier working of the soil possible in spring and helps increase the rooting depth for plants. Included with Powell soils in this map unit are Wollent and Wapato soils.

Soils in the Quatama-Quafeno-Wollent map unit are wet and subject to ponding. They are used for pasture, row crops, and berries. Drainage systems improve soil conditions for cropping. Included in this map unit are Aloha, Latourell, and Burlington soils.

Soils in the Sauvie-Raton-Pilchuck map unit have excellent potential for farming where they are protected

from flooding. These soils are used for row crops, nursery stock, and pasture. Crop production is better where sufficient drainage has been provided than where undrained. Wetland wildlife developments are successful on some soils in this map unit. Wetness is a limitation for nonfarm uses. Included in this map unit are Burlington, Faloma, Moag, and Sifton soils.

Climate is a limitation to farming in the Cazadero-Haplumbrept and the Bull Run-Mershon map units. Some areas, however, are used successfully for berries and nursery stock. The soils in these map units are well suited to woodland or pasture, though some steeply sloping areas cannot be grazed. Included with the Cazadero-Haplumbrept map unit are Aschoff, Mershon, and Dabney soils. Parts of the Bull Run-Mershon map unit are exposed to severe winds, limiting woodland and other uses. Included in the Bull Run-Mershon map unit are Aschoff and Dabney soils and Haplumbrepts.

Soils in the Zygore map unit are at a high elevation and are well suited to woodland. Much of the area of this map unit is in the National Forest and is important wildlife habitat. Included in this map unit are Aschoff soils.

In the hilly Cascade-Urban land-Cornelius map unit unstable soils are a hazard to development. Much of the area of this map unit has been set aside for parks and wildlife sanctuaries. Some small areas are in farms and ranches, and some areas are in productive woodlots. Windthrow is a common concern because of the shallow rooting on wet soils. Nurseries and orchards are successful on these soils. Included in this map unit are Delena, Goble, Helvetia, and Saum soils.

Soils in the Goble-Wauld map unit have more climatic limitations for farming than the soils in other map units in the county. The soils in this map unit are mostly used for pasture and woodlots. Other uses are for homesites and wildlife habitat. Included in this map unit are Cascade, Delena, and Quatama soils.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

This survey was mapped at two levels of detail. The more detailed survey is identified by narrowly defined map units. The less detailed part is identified by more broadly defined units. The broadly defined units are identified by an asterisk in the soil map legend. In the more narrowly defined units, the soil delineation boundaries were plotted and verified at closely spaced intervals. In the more broadly defined units, the soil delineation boundaries were plotted and verified by some observations. The intensity of mapping selected was based on the anticipated long-term use of the survey, and the map units were designed to meet the needs for that use.

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a similar profile make up a soil series. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, ero-

Figure 3. - Housing development on Cascade silt loam.

sion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Cascade silt loam, 3 to 8 percent slopes, is one of several phases within the Cascade series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and soil associations.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Cascade-Urban land complex, 0 to 8 percent slopes, is an example.

A *soil association* is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Kinzel-Divers-Goodlow association, steep, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Riverwash is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map (28).

The acreage and proportionate extent of each map unit are given in table 13, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

1A-Aloha silt loam, 0 to 3 percent slopes. This somewhat poorly drained soil is on broad valley terraces. This soil formed in mixed alluvium or lacustrine silt. Elevation is 150 to 350 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is dark brown and grayish brown, mottled silt loam about 39 inches thick. The substratum is yellowish brown, mottled silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Quatama, Wollent, and steeper Aloha soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Available water capacity is 11 to 13 inches. Water-supplying capacity is 18 to 20 inches. Effective rooting depth is 40 to 60 inches. The lower part of the subsoil and the upper part of the substratum ranges from a slightly brittle layer to a fragipan that is weak. A water table is at a depth of less than 2 feet from December to April. It commonly is perched on the brittle layer. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, urban development, and wildlife habitat.

This soil is suited to farming. If this soil is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. Major crops are grain, hay, pasture, vegetables, and berries. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Fall plowing, fertilizing, and seeding to a cover crop help reduce runoff and erosion.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used. Irrigation water needs to be applied carefully at rates low enough to prevent runoff. Grain and grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime. Vegetables and berries respond to nitrogen, phosphorus, and potassium.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, western hazel, willow, trailing blackberry, rose, brackenfern, grasses, and forbs.

Native areas of this soil support a mixture of trees, shrubs, and grasses that provide excellent food and cover for many kinds of wildlife. When areas are used in a monoculture, the distribution of cover and food for maximum wildlife populations is not balanced. The potential for wildlife habitat is good. Planting desirable vegetation and protecting and managing existing vegetation, particularly in fence rows, improve the habitat. Resident and seasonal wildlife include ring-necked pheasant, California quail, mourning dove, band-tailed pigeon, foxes, raccoon, opossum, squirrels, skunks, rabbits, mice, moles, and gopher. Nongame birds include hawks, owls, jays, crows, woodpeckers, flycatchers, and many kinds of small birds.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations

for urban development are the seasonal high water table and moderately slow permeability. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by a seasonal high water table.

This soil is in capability subclass llw.

1B-Aloha silt loam, 3 to 8 percent slopes. This somewhat poorly drained soil is on broad valley terraces. This soil formed in mixed alluvium or lacustrine silt. Elevation is 150 to 350 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is dark brown and grayish brown, mottled silt loam about 39 inches thick. The substratum is yellowish brown, mottled silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Quatama, Wollent, and other Aloha soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Available water capacity is 11 to 13 inches. Water-supplying capacity is 18 to 20 inches. Effective rooting depth is 40 to 60 inches. The lower part of the subsoil and the upper part of the substratum ranges from a slightly brittle layer to a fragipan that is very weak. A water table is at a depth of less than 2 feet from December to April. It commonly is perched on the brittle layer. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, urban development, and wildlife habitat.

This soil is suited to farming. If this soil is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. Major crops are grain, hay, pasture, vegetables, and berries. Returning all crop residue to the soil helps reduce rill and sheet erosion. Including grasses, legumes, or grass-legume mixtures in the cropping system helps maintain fertility and tilth. Fall plowing, fertilizing, and seeding to a cover crop help reduce runoff and erosion.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is most successful when the soil is dry. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used. Sprinkler irrigation helps increase crop production in dry periods in summer. Water needs to be applied carefully at rates low enough to prevent runoff. Grain and grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime. Vegetable crops and berries respond to nitrogen, phosphorus, and potassium.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, western hazel, willow, trailing blackberry, roses, brackenfern, grasses, and forbs.

Native areas of this soil support a mixture of trees, shrubs, and grasses that provide excellent food and cover for many kinds of wildlife. When areas are used in a monoculture, the distribution of cover and food for maximum wildlife populations is not balanced. The potential for wildlife habitat is good. Planting desirable vegetation and protecting and managing existing vegetation, particularly in fence rows, improve the habitat. Resident and seasonal wildlife species include ring-necked pheasant, California quail, mourning dove, band-tailed pigeon, foxes, raccoon, opossum, squirrels, skunks, rabbits, mice, moles, and gophers. Nongame birds include hawks, owls, jays, crows, woodpeckers, flycatchers, and many kinds of small birds.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are the seasonal high water table and the moderately slow permeability. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by a seasonal high water table.

This soil is in capability subclass llw.

2A-Aloha-Urban land complex, 0 to 3 percent slopes. This complex consists of very deep, somewhat poorly drained Aloha soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad valley terraces that have long, concave slopes. Areas are generally irregular in shape and 15 to 100 acres in size. The Aloha soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 150 to 350 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Aloha soils that are relatively undisturbed. Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is dark brown and grayish brown, mottled silt loam about 39 inches thick. The substratum is yellowish brown, mottled silt loam to a depth of 60 inches or more.

About 30 percent of this complex are areas of Aloha soils that have been disturbed. These soils have been

covered by as much as 20 inches of fill material, or as much as 30 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Aloha soils that have been cut or graded.

About 40 percent of the complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Quatama and Wollent soils. The included soils make up about 10 percent of this complex.

In areas where the soils are relatively undisturbed, permeability is moderately slow, and available water capacity is 11 to 13 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. In undisturbed areas, the lower part of the subsoil and the upper part of the substratum range from slightly brittle to a fragipan that is very weak. Undisturbed areas of Aloha soils have a water table within a depth of 2 feet during December to April. The water table is commonly perched on the brittle layer. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are a seasonal high water table and moderately slow permeability. Large areas of this unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by the seasonal high water table.

This map unit is not assigned to a capability subclass.

3D-Aschoff cobbly loam, 5 to 30 percent slopes.

This well drained soil is in mountainous areas along the Columbia and Sandy Rivers and their tributaries. This soil formed in colluvium weathered from basalt and andesite mixed with a small amount of loess and volcanic ash. Elevation is 100 to 1,600 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 200 days.

Typically, the surface layer is very dark brown and dark brown cobbly loam about 12 inches thick. The subsoil is dark brown very cobbly loam about 22 inches thick. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Included with this soil in mapping and making up as much as 15 percent of this map unit are areas of Bull Run soils, steeper Aschoff soils, and Rock outcrop. Also included and making up as much as 5 percent are soils that are similar to this Aschoff soil but have bedrock at a depth of 20 to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is medium, and the hazard of erosion is moderate.

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

The vegetation is Douglas-fir, red alder, western redcedar, vine maple, western hazel, bigleaf maple, dogwood, red huckleberry, swordfern, and forbs. A limited amount of western hemlock is on ridgetops in places above an elevation of 1,200 feet.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 130 to 150. Based on a site index of 140, this soil is capable of producing about 9,650 cubic feet from a fully stocked stand of 70-year old trees, or 52,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, bigleaf maple, and red alder restrict natural regeneration of Douglas-fir.

The major limitation for timber production is high content of coarse fragments. Conventional logging methods are generally suitable for tree harvest, but when the soil is wet some conventional systems may be limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas on the western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops most of the ground vegetation decreases, and the black-tailed deer population returns to a low level. Species such as blue grouse are favored as the trees grow larger. Habitat is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

The high concentration of coarse fragments is an important limitation for such community uses as landfills, dwellings, roads, septic tank absorption fields, and sewage lagoons. Climatic conditions are severe. Winter is long and cold, summer is short and cool, and high winds occur during winter and spring. Only plants adapted to these severe weather conditions should be used for landscaping. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Mulching and fertilizing cut areas

help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass Vls.

3E-Aschoff cobbly loam, 30 to 60 percent slopes.

This well drained soil is in mountainous areas along the Columbia and Sandy Rivers and their tributaries. This soil formed in colluvium weathered from basalt and andesite mixed with a small amount of volcanic ash. Elevation is 100 to 1,600 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 200 days.

Typically, the surface layer is very dark brown and dark brown cobbly loam about 12 inches thick. The subsoil is dark brown very cobbly loam about 22 inches thick. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Included with this soil in mapping and making up as much as 15 percent of this map unit are areas of Bull Run, Wahkeena, and Zygore soils, other Aschoff soils, and Rock outcrop. Also included and making up as much as 5 percent are soils that are similar to this Aschoff soil but have bedrock at a depth of 20 to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

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

The vegetation is Douglas-fir, red alder, western redcedar, vine maple, western hazel, bigleaf maple, dogwood, red huckleberry, swordfern, and forbs. A limited amount of western hemlock is on north-facing slopes in places.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 140 to 155. Based on a site index of 149, this soil is capable of producing about 10,550 cubic feet from a fully stocked stand of 70-year old trees, or 61,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

The major limitations for timber production are slopes and high content of coarse fragments. Because of the steep slopes, such methods of logging as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas on the western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on clearing of the land and on availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

The high concentration of coarse fragments and slopes of 30 to 60 percent are important limitations for such community uses as landfills, dwellings, small buildings, roads, septic tank absorption fields, and sewage lagoons. Climatic conditions are severe. Winter is long and cold, summer is short and cool, and high winds occur in winter and early in spring. Only plants adapted to these severe weather conditions should be used for landscaping. Irrigation during summer is desirable for lawn grasses, shrubs, vines, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass Vls.

3F-Aschoff cobbly loam, 60 to 80 percent slopes.

This well drained soil is in steep mountainous areas along the Columbia and Sandy Rivers and their tributaries. This soil formed in colluvium weathered from basalt and andesite mixed with a small amount of volcanic ash. Elevation is 100 to 1,600 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 200 days.

Typically, the surface layer is very dark brown and dark brown cobbly loam about 12 inches thick. The subsoil is dark brown very cobbly loam about 22 inches thick. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Included with this soil in mapping and making up as much as 20 percent of this map unit are areas of Bull Run, Wahkeena, and Zygore soils, other Aschoff soils, and Rock outcrop. Also included and making up as much as 5 percent are soils that are similar to this Aschoff soil but have bedrock at a depth of 20 to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

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

The vegetation is Douglas-fir, red alder, western redcedar, vine maple, western hazel, bigleaf maple, dogwood, red huckleberry, swordfern, and forbs. A limited amount of western hemlock is on north-facing slopes in places.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 150 to 165. Based on a site index of 158, this soil is capable of producing

about 11,230 cubic feet from a fully stocked stand of 70-year old trees, or 68,320 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

The major limitations for timber production are slopes and high content of coarse fragments. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvest. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brush removal and tree planting are restricted by slopes of 60 to 80 percent.

In the high rainfall areas on the western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops, most of the ground vegetation decreases, and the black-tailed deer population returns to a low level. Species such as blue grouse are favored as the trees grow larger. Habitat is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

Slopes of 60 to 80 percent and high concentration of coarse fragments are important limitations for such community uses as landfills, dwellings, roads, and septic tank absorption fields. Climatic conditions are severe. Winter is long and cold, summer is short and cool, and high winds occur in winter and early in spring. Only plants adapted to these severe weather conditions should be used for landscaping. Mulching and fertilizing cut areas help establish plants.

This soil is in capability subclass VIIs.

Figure 4.- Aschoff-Rock outcrop-Wahkeena association on canyon side slopes above areas of Quatama soils along the Columbia River.

4F-Aschoff-Rock outcrop-Wahkeena association, very steep. These well drained soils are on the side slopes of canyons in mountains along the Columbia River (fig. 4). They formed in colluvium weathered from basalt and andesite mixed with a small amount of volcanic ash. Elevation is 50 to 2,800 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 200 days.

This association is about 50 percent Aschoff soil, 25 percent Rock outcrop, and 15 percent Wahkeena soil. The extent of these soils and Rock outcrop vary from one area to another. Included with this association in mapping and making up as much as 10 percent of this map unit are areas of Mershon and Bull Run soils, Rubble land, and soils that are shallow to bedrock.

The Aschoff soil has convex slopes and is between draws and areas of Rock outcrop. Typically, the surface layer is very dark brown and dark brown cobbly loam about 12 inches thick. The subsoil is dark brown very cobbly loam about 22 inches thick. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

The Wahkeena soil is in draws, on foot slopes, and below areas of Rock outcrop where increased volume of surface runoff is common. Typically, the surface layer is very dark brown very cobbly clay loam about 14 inches thick. The subsoil is dark brown extremely cobbly clay loam about 46 inches thick. Basalt bedrock is below a depth of 60 inches.

Permeability is moderate in the Aschoff soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

Permeability is moderately rapid in the Wahkeena soil. Effective rooting depth is 60 inches or more. Available water capacity is 3 to 7 inches. Water-supplying capacity is 18 to 21 inches. Runoff is rapid, and the hazard of erosion is high.

This association is mainly used for wildlife habitat. It has limited use for timber production.

The vegetation on the Aschoff and Wahkeena soils is Douglas-fir, bigleaf maple, red alder, vine maple, western hazel, dogwood, Cascade Oregon-grape, trailing blackberry, salal, common snowberry, roses, and swordfern. At elevations above 1,700 feet and on north-facing slopes western hemlock and red huckleberry are common.

The production of Douglas-fir in this association is limited. The site index for Douglas-fir on Aschoff soils ranges from 150 to 165. Based on a site index of 158, the Aschoff soils are capable of producing about 11,230 cubic feet from a fully stocked stand of 70-year old trees, or 68,320 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. The site index for Douglas-fir on Wahkeena soils ranges from 125 to 140. Based on a site index of 129, the Wahkeena soils are capable of producing about 8,490 cubic feet from a fully stocked stand of 70-year old trees, or 41,650 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

The major limitations for timber production are areas of Rock outcrop, slopes of 60 to 90 percent, and general inaccessibility of the areas. Because of the steep slopes, such methods of logging as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brush removal and tree planting are restricted by the very steep slopes.

In the high rainfall areas along the Columbia River, vegetation grows rapidly. The potential for wildlife, especially black-tailed deer, depends on the amount of Rock outcrop, the amount of clear-cutting, and the availability of new growth of trees, shrubs, and grasses.

In mature stands of Douglas-fir, ground vegetation decreases and the black-tailed deer population stays at a low level. Species such as blue grouse are favored (fig. 5). Habitat is suitable for such other species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, eagles, jays, ravens, vultures, woodpeckers, mountain quail, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

The slopes of 60 to 90 percent, high concentration of coarse fragments, and outcrops of rock are important limitations for such community uses as landfills, dwellings, small buildings, roads, and septic tank absorption fields. Climatic conditions are severe. Winter is long, summer is short and cool, and high winds occur during winter and spring. Only plants adapted to these severe weather conditions should be used in landscaping. Mulching and fertilizing cut areas help establish plants.

The Aschoff and Wahkeena soils are in capability subclass VIIs and Rock outcrop is in capability subclass VIIIs.

Figure 5.- Blue grouse are common along fringe areas of mature stands of Douglas-fir on Aschoff soils.

5B-Bull Run silt loam, 3 to 8 percent slopes. This well drained soil is on rolling ridgetops. This soil formed in silty materials mixed with volcanic ash. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick. The subsoil is dark yellowish brown silt loam about 26 inches thick. The substratum is dark yellowish brown silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff and Mershon soils and more steeply sloping Bull Run soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 15 inches. Water-supplying capacity is 22 to 26 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for timber production, forage crops, urban development, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and

lime and in places, to boron. Legumes are restricted by the short growing season and cool temperatures.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, western redcedar, western hemlock, vine maple, creambush oceanspray, trailing blackberry, salal, Oregon oxalis, swordfern, brackenfern, grasses, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 175. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species including vine maple, salal, and red alder restrict natural regeneration of Douglas-fir.

If the soil is wet, the use of some conventional logging methods is limited in areas. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, particularly black-tailed deer, depends upon the stage of plant growth or the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level and species such as blue grouse are favored. In areas of mixed woodland and pasture, habitat is suitable for many species, including Roosevelt elk, mountain quail, and ruffed grouse. Other wildlife species are coyote, bobcat, skunks, weasels, beaver, raccoon, mink, opossum, rabbits, squirrels, and mice. Birds that are resident or seasonal include hawks, owls, eagles, jays, ravens, vultures, woodpeckers, larks, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities. In areas of pasture, planting desirable vegetation and maintaining fence rows provide food and improve the habitat for wildlife.

This soil has no major limitations for homesites or other urban uses. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Development is limited in places by the wet, cold climate in winter.

This soil is in capability subclass VIe.

5C-Bull Run silt loam, 8 to 15 percent slopes. This well drained soil is on rolling ridgetops. This soil formed in silty materials mixed with volcanic ash. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick. The subsoil is dark yellowish brown silt loam about 26 inches thick. The substratum is dark yellowish brown silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff and Mershon soils and other Bull Run soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 15 inches. Water-supplying capacity is 22 to 26 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for timber production, forage crops, urban development, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Tilling and planting across the slope help control erosion. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Legumes are restricted by the short growing season and cool temperatures.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, western redcedar, western hemlock, vine maple, creambush oceanspray, trailing blackberry, Oregon oxalis, swordfern, brackenfern, grasses, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 175. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, common snowberry, and red alder, restrict natural regeneration of Douglas-fir.

If the soil is wet, the use of some conventional logging systems is limited in areas. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, particularly black-tailed deer, depends upon the stage of vegetation or the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the deer population returns to a low level and species such as blue grouse are favored. In areas of mixed woodland and pasture, habitat is suitable for many species including Roosevelt elk, mountain quail, and ruffed grouse. Other wildlife species are coyote, bobcat, skunks, weasels, beaver, raccoon, mink, opossum, rabbits, squirrels, and mice. Birds that are resident or sea-

sonal include hawks, owls, eagles, jays, ravens, vultures, woodpeckers, larks, and many kinds of small birds. Most of the potential for improving wildlife habitat depends on the management of existing plant communities. In areas of pasture, planting desirable vegetation and maintaining fence rows provide food and improve the habitat for wildlife.

Slopes of 8 to 15 percent are the major limitation for homesites and other urban uses. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Development is limited in places by the wet, cold climate in winter.

This soil is in capability subclass Vle.

5D-Bull Run silt loam, 15 to 30 percent slopes.

This well drained soil is on rolling ridgetops. This soil formed in silty materials mixed with volcanic ash. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick. The subsoil is dark yellowish brown silt loam about 26 inches thick. The substratum is dark yellowish brown silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff and Mershon soils and other Bull Run soils that are more sloping or less sloping than this soil. The included soils make up as much as 15 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 15 inches. Water-supplying capacity is 22 to 26 inches. Runoff is medium, and the hazard of erosion is high.

This soil is used for timber production, forage crops, urban development, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Tilling and planting across the slope help reduce erosion. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Legumes are restricted by the short growing season and cool temperatures.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, western redcedar, western hemlock, vine maple, creambush oceanspray, trailing blackberry, Oregon oxalis, swordfern, brackenfern, grasses, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 175. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, common snowberry, and red alder, restrict natural regeneration of Douglas-fir.

If the soil is wet, the use of some conventional logging systems is limited in areas. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, particularly black-tailed deer, depends upon the stage of vegetation or the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the deer population returns to a low level and species such as blue grouse are favored.

In areas of mixed woodland and pasture, habitat is suitable for many species including Roosevelt elk, mountain quail, and ruffed grouse. Other wildlife species are coyote, bobcat, skunks, weasels, beaver, raccoon, mink, opossum, rabbits, squirrels, and mice. Birds that are resident or seasonal include hawks, owls, eagles, jays, ravens, vultures, woodpeckers, larks and many kinds of small birds. Most of the potential foil wildlife habitat depends on the management of existing plant communities. In areas of pasture, planting desirable vegetation and maintaining fence rows provide food and improve the habitat for wildlife.

This soil is not well suited to homesites and other urban uses because of slopes of 15 to 30 percent. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Development is limited in places by the wet, cold climate in winter.

This soil is in capability subclass Vle.

5E-Bull Run silt loam, 30 to 60 percent slopes.

This steep, well drained soil is on side slopes of broad, rolling ridgetops. This soil formed in silty materials mixed with volcanic ash. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick. The subsoil is dark yellowish brown silt loam about 26 inches thick. The substratum is dark yellowish brown silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff and Mershon soils and less steeply sloping Bull Run soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 15 inches. Water-supplying capacity is 22 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

This soil is used for timber production, urban development, and wildlife habitat.

The vegetation is Douglas-fir, red alder, bigleaf maple, western redcedar, western hemlock, vine maple, creambush oceanspray, trailing blackberry, Oregon oxalis, swordfern, brackenfern, grasses, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 175. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species including salal, Cascade Oregon-grape, common snowberry, and red alder restrict natural regeneration of Douglas-fir.

Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Road cuts require additional maintenance because of slumping. All-season roads on this soil need a heavy base of rock.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, particularly black-tailed deer, depends upon the stage of plant growth or the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level and species such as blue grouse are favored. In areas of mixed woodland and pasture, habitat is suitable for many species, including Roosevelt elk, mountain quail, and ruffed grouse. Other wildlife species are coyote, bobcats, skunks, weasels, beaver, raccoon, mink, opossum, rabbits, squirrels, and mice. Birds that are resident or seasonal include hawks, owls, eagles, jays, ravens, vultures, woodpeckers, larks, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

This soil is not well suited to homesites and other urban uses because of slopes of 30 to 60 percent. Slumping occurs in areas of cut and fill, and additional maintenance is required for banks, roads, and building foundations. Irrigation during summer is desirable for lawn grasses, shrubs, vines, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Development is limited in places by the wet, cold climate in winter.

The soil is in capability subclass Vle.

5F-Bull Run silt loam, 60 to 80 percent slopes.

This steep, well drained soil is on side slopes of broad, rolling ridgetops. This soil formed in silty materials mixed with volcanic ash. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 48 to 54 degrees F, and the frost-free period is 100 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick. The subsoil is dark yellowish brown silt loam about 26 inches thick. The substratum is dark yellowish brown silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff and Mershon soils and other Bull Run soils that are less steeply sloping than this Bull Run soil. The included soils make up as much as 15 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 15 inches. Water-supplying capacity is 22 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

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

The vegetation is Douglas-fir, red alder, bigleaf maple, western redcedar, western hemlock, vine maple, creambush oceanspray, trailing blackberry, Oregon oxalis, swordfern, brackenfern, grasses, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 175. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species including salal, Cascade Oregon-grape, common snowberry, and red alder restrict natural regeneration of Douglas-fir.

Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Slumping occurs, and additional maintenance is required on road cuts. All-season roads on this soil need a heavy base of rock.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, particularly black-tailed deer, depends upon the stage of plant growth or the availability of new growth of trees, shrubs, and grasses. As new forest develops and the ground vegetation decreases, the black-tailed deer population returns to a low level and species such as blue grouse are favored. In areas of mixed woodland and pasture, habitat is suitable for many species, including Roosevelt elk, mountain quail, and ruffed grouse. Other wildlife species are coyote, bobcat, skunks, weasels, beaver, raccoon, mink, opossum, rabbits, squirrels, and mice. Birds that are resident or seasonal include hawks, owls, eagles, jays, ravens, vultures, woodpeckers, larks, and many kinds of small birds. Most

of the potential for wildlife habitat depends on the management of existing plant communities.

This soil has severe limitations for homesites and other urban uses because of slopes of 60 to 80 percent. Slumping occurs in areas of cut and fill, and additional maintenance is required for banks, roads, and building foundations. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, vines, and shrubs. Soil washing on disturbed areas can be controlled with cover crops. Mulching and fertilizing help establish plants in disturbed areas. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Development is limited in some areas by the wet, cold climate during winter.

This soil is in capability subclass Vile.

6B-Burlington fine sandy loam, 0 to 8 percent slopes. This somewhat excessively drained soil is on terraces along the lower Columbia River and its tributaries. This soil formed in alluvium that has been re-worked by wind to form rolling dune-like topography. Elevation is 20 to 50 feet. The average annual precipitation is 40 to 65 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown fine sandy loam about 12 inches thick. The substratum is dark brown and dark yellowish brown loamy fine sand to a depth of 60 inches or more.

Included with this soil in mapping and making up as much as 5 percent of the map unit are areas of Sauvie, Quafeno, and Latourell soils. Also included and making up as much as 10 percent are areas that are mapped as Burlington soils, but they do not have a dark colored surface layer. These areas are in T. 1 N., R. 4 E., and on larger islands in the Columbia River.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is 7 to 8 inches. Water-supplying capacity is 17 to 20 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, nursery crops, urban development, and wildlife habitat.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, western hazel, common snowberry, tall Oregon-grape, creambush oceanspray, roses, willow, trailing blackberry, brackenfern, forbs, and grasses.

This soil is well suited to farming. If this soil is irrigated, most climatically adapted crops do well. The major crops are nursery stock, vegetables, berries, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare over winter, it should be fertilized and planted to a cover crop in fall. Limiting tillage to seedbed preparation and weed control helps control blowing. A cloddy condition helps protect the soil from erosion during windy periods. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Sprinkler irrigation helps increase crop production in dry periods in summer. Irrigation water needs to be applied carefully at rates low enough to prevent runoff.

A variety of grasses, vegetables, fruits, and nursery crops along with shrubs and trees is grown on this soil. This variety of plants furnish good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to bodies of water, it provides food and habitat for numerous waterfowl. The potential for wildlife habitat is good. Planting desirable vegetation and protecting and managing existing vegetation improve the habitat.

This soil has no major limitations for urban development. Cut banks and other excavations are not stable and are subject to slumping. Soil blowing is a concern in disturbed areas in places but can be controlled by mulching. Septic tank absorption fields contaminate adjacent water sources in places because of the rapid permeability. Irrigation during summer is required for best results with lawn grasses, shrubs, vines, shade trees, and ornamental trees. Establishing plants in disturbed areas is difficult. Mulching, fertilizing, and irrigating help to establish plants.

This soil is in capability subclass IIe.

6C-Burlington fine sandy loam, 8 to 15 percent slopes. This somewhat excessively drained soil is on terraces along the lower Columbia River and its tributaries. This soil formed in alluvium. Elevation is 20 to 50 feet. The average annual precipitation is 40 to 65 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown fine sandy loam about 12 inches thick. The substratum is dark brown and dark yellowish brown loamy fine sand to a depth of 60 inches or more.

Included with this soil in mapping and making up as much as 5 percent of the mapped areas are Sauvie, Quafeno, and Latourell soils. Also included and making up as much as 10 percent are areas of Burlington soils that have a surface layer of loamy fine sand which is not dark colored. These areas are in T. 1 N., R. 4 E., and on larger islands in the Columbia River.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is 7 to 8 inches. Water-supplying capacity is 17 to 20 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for farming, nursery crops, urban development, and wildlife habitat.

This soil is well suited to farming. If this soil is irrigated, most climatically adapted crops do well. The major

crops are nursery stock, vegetables, berries, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Limiting tillage to seedbed preparation and weed control helps control blowing. A cloddy condition helps protect the soil against erosion during windy periods. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places to boron. Sprinkler irrigation helps increase crop production in dry periods in summer. Irrigation water needs to be applied carefully at rates low enough to prevent runoff.

The vegetation in areas not cultivated is Oregon white oak, Douglas-fir, western redcedar, western hazel, tall Oregon-grape, willow, roses, trailing blackberry, common snowberry, brackenfern, forbs, and grasses.

A wide variety of grasses, vegetables, and nursery crops along with shrubs and trees are grown on this soil. These plants furnish good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to bodies of water, it provides food and habitat for numerous waterfowl. The potential for wildlife habitat is good. Planting desirable vegetation and managing and protecting existing vegetation improve the habitat.

This soil has no major limitations for urban development; however, slopes of 8 to 15 percent can be a concern in places. Cut banks and other excavations are not stable, and slumping is possible. Soil blowing is a concern in disturbed areas in places but can be controlled by mulching. Septic tank absorption fields in places contaminate adjacent water sources because of the rapid permeability. Irrigation during summer is required for best results with lawn grasses, shrubs, vines, shade trees, and ornamental trees. Establishing plants in disturbed areas is difficult. Mulching, fertilizing, and irrigating help establish plants.

This soil is in capability subclass IIIe.

7B-Cascade silt loam, 3 to 8 percent slopes. This somewhat poorly drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in silty materials. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Goble and Cornelius soils and steeper Cascade soils. The included soils make up as much as 10 percent of this map unit. Also included in Tps. 1 N. and 1 S., R. 1 E., are areas mapped as Cascade soils, but these soils in places have basalt bedrock at a depth of 40 to 60 inches.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 18 to 30 inches from December through April.

This soil is used for farming, timber production, urban development, and wildlife habitat.

This soil is well suited to farming. If the soil is drained, most climatically adapted crops do well. The major crops are grain, berries, vegetables, nursery stock, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. The soil has a perched water table in winter and early in spring. Tile systems are difficult to install because of shallow depth to the hardpan. Tile systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, roses, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, common snowberry, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 150 to 165. Based on a site index of 157, this soil is capable of producing about 10,720 cubic feet from a fully stocked stand of 70-year old trees, or 63,280 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations to timber production are the slowly permeable fragipan at a depth of 20 to 30 inches

and the resultant perched water table from December through April. Some windthrow of trees is possible because of restricted rooting depth. When the soil is wet, the use of some conventional logging systems is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

This soil is along a fringe area that is transitional from valley to forested hills. Openland and woodland are almost equal in extent. A wide variety of grain and grasses along with shrubs and trees furnish good food and cover for wildlife. Resident and seasonal wildlife in areas of this soil include black-tailed deer, Roosevelt elk, black bear, coyote, bobcat, raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning doves, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds. Potential is good for building ponds for fish and wildlife on this soil. Ponds have been built, and fish production generally is good in these ponds. Most of the potential for wildlife habitat depends on the management of existing plant communities, but some potential, depends on growing desirable vegetation.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are the seasonal water table, slow permeability, and a fragipan at a depth of 20 to 30 inches. Dwellings and roads must be designed to offset these limitations. Excavation during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Recreational uses are limited by the seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIw.

7C-Cascade slit loam, 8 to 15 percent slopes. This somewhat poorly drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in silty materials. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled**,** silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Goble and Cornelius soils and other Cascade soils. The included soils make up as much as 10 percent of this unit. Also included in Tps. 1 N. and 1 S., R. 1 E., are areas of Cascade soils, but in places these soils have basalt bedrock at a depth of 40 to 60 inches.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is at a depth of 18 to 30 inches from December through April.

This soil is used for farming, timber production, urban development, and wildlife habitat.

This soil is suited to farming. If this soil is drained, most climatically adapted crops do well. The major crops are grain, berries, vegetables, nursery stock, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps to control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet.

The soil has a perched water table in winter and early in spring. Tile systems are difficult to install because of shallow depth to the hardpan. Tile systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, common snowberry, roses, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 150 to 165. Based on a site index of 157, this soil is capable of producing about 10,720 cubic feet from a fully stocked stand of 70-year old trees, or 63,280 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations to timber production are the slowly permeable fragipan at a depth of 20 to 30 inches

and the resultant perched water table from December through April. Some windthrow of trees is possible because of restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

This soil is along a fringe area that is transitional from valley to forested hills. Openland and woodland are almost equal in extent. A wide variety of grain and grasses along with shrubs and trees furnish good food and cover for wildlife.

Resident and seasonal wildlife in areas of this soil include black-tailed deer, Roosevelt elk, black bear, coyote, bobcat, raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds. Potential is good for building ponds for fish and wildlife on this soil. Ponds have been built, and fish production is generally good in these ponds. Most of the potential for wildlife habitat depends on the management of existing plant communities, but some potential depends on growing desirable vegetation.

Increased population growth has resulted in increased homesite construction on this soil (fig. 6). The main limitations for urban development are the seasonal high water table, slow permeability, low strength, a fragipan at a depth of 20 to 30 inches, and slopes of 8 to 15 percent. Dwellings and roads need to be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Recreational uses are limited by slope and a seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

Figure 6.- Homesites on Cascade silt loam.

7D-Cascade slit loam, 15 to 30 percent slopes.

This somewhat poorly drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in silty materials. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Goble and Cornelius soils and other Cascade soils. The included soils make up as much as 15 percent of this map unit. Also included in Tps. 1 N. and 1 S., R. 1 E., are areas of Cascade soils, but in places these soils have basalt bedrock at a depth of 40 to 60 inches.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is medium, and the hazard of erosion is high. A water table is at a depth of 18 to 30 inches from December through April.

This soil is used for farming, timber production, urban development, and wildlife habitat.

The native vegetation is Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, roses, swordfern, common snowberry, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 150 to 165. Based on a site index of 157, this soil is capable of producing about 10,720 cubic feet from a fully stocked stand of 70-year old trees, or 63,280 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, in-

cluding salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the slowly permeable fragipan at a depth of 20 to 30 inches and the resultant perched water table from December through April. Some windthrow of trees is possible because of the restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

This soil is poorly suited to farming. If this soil is drained, most climatically adapted crops do well. The major crops are grain, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Tilling and planting across the slope help reduce runoff and erosion. If the soil is to be left bare over winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in the formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. The soil has a perched water table in winter and early in spring. Tile systems are difficult to install because of shallow depth to the hardpan. Tile systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

This soil is along a fringe area that is transitional from valley to forested hills. Openland and woodland are almost equal in extent. A wide variety of grain and grasses along with shrubs and trees furnishes good food and cover for wildlife.

Resident and seasonal wildlife in areas of this soil, include black-tailed deer, Roosevelt elk, black bear, coyote, bobcat, raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities, but some potential depends on growing desirable vegetation.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are a seasonal high water table, slow permeability, low strength, a fragipan at a depth of 20 to 30 inches, and slopes of 15 to 30 percent. Dwellings and roads need to be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. Slumping is possible in areas of cut and fill, and additional maintenance is required for banks, roads, and building foundations. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness, steep slopes, and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Recreational uses are limited by the seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IVe.

7E-Cascade silt loam, 30 to 60 percent slopes. This steep, somewhat poorly drained soil is on side slopes of broad, rolling ridgetops. This soil formed in silty materials. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Goble, Cornelius, Saum, and Wauld soils and other Cascade soils. The included soils make up as much as 15 percent of this unit. Also included in Tps. 1 N. and 1 S., R 1 E., are areas of Cascade soils, but in places these soils have basalt bedrock at a depth of 40 to 60 inches.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is rapid, and the hazard of erosion is high. A water table is at a depth of 18 to 30 inches from December through April.

This soil is used for timber production, urban development, and wildlife habitat.

The native vegetation is Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, roses, swordfern, common snowberry, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 150 to 165. Based on a site index of 157, this soil is capable of producing

about 10,720 cubic feet from a fully stocked stand of 70-year old trees, or 63,280 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations to timber production are the slowly permeable fragipan at a depth of 20 to 30 inches and the resultant perched water table from December through April. Some windthrow of trees is possible because of restricted rooting depth. Because of the steep slopes, such logging methods as aerial, high-lead or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Slumping occurs on road cuts and requires additional maintenance. All-season roads on this soil need a heavy base of rock.

This soil is along the fringe of the valley in areas which are transitional from valley to forested hills. The extent of openland and woodland is almost equal. A wide variety of grain and grasses along with shrubs and trees furnishes good food and cover for wildlife.

Resident and seasonal wildlife in areas of this soil include black-tailed deer, Roosevelt elk, black bear, coyote, bobcat, raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

Increased population growth has resulted in increased homesite construction on this Cascade soil. This soil has severe limitations for dwellings and roads because of depth to the hardpan, slopes of 30 to 60 percent, and a seasonal high water table. Dwellings and roads need to be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted hardpan. A seasonal water table is perched on top of the hardpan in this soil and requires drainage for best results with basements and crawl spaces. If adequate drainage is not provided, areas of cut and fill slump in places and cause additional concerns in landscaping, road construction, and maintaining building foundations. Septic tank absorption fields do not function properly during rainy periods because of wetness, slope gradient, and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Recreational uses are limited by the seasonal high water table.

This soil is in capability subclass Vle.

8B-Cascade-Urban land complex, 0 to 8 percent slopes. This complex consists of somewhat poorly drained Cascade soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on convex side slopes of broad, rolling ridgetops. Areas are generally irregular in shape and 15 to 100 acres in size. The Cascade soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature , is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Cascade soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more.

About 30 percent of this complex are areas of Cascade soils that have been disturbed. These soils have been covered by as much as 20 inches of fill material, or as much as 30 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Cascade soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Goble and Cornelius soils and steeper Cascade soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is slow and available water capacity is 5 to 7.5 inches. In areas dominated by cuts, fills, and Urban land permeability and available water capacity are variable. Undisturbed areas of Cascade soils have a water table within a depth of 30 inches during December to April. The water table is perched on the fragipan. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are the seasonal high water table, the slow permeability, and a fragipan at a depth of 20 to 30 inches. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage to be provided for best results with basements and crawl spaces.

Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal water table and droughty conditions should be selected if drainage and irrigation are not provided. Rec-

reational uses are limited by the seasonal high water table.

This map unit is not assigned to a capability subclass.

8C-Cascade-Urban land complex, 8 to 15 percent slopes. This complex consists of somewhat poorly drained Cascade soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on convex side slopes of broad, rolling ridgetops. Areas are generally irregular in shape and 15 to 100 acres in size. The Cascade soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Cascade soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more.

About 30 percent of this complex are areas of Cascade soils that have been disturbed. These soils are covered by as much as 30 inches of fill material, or as much as 50 inches of the original soil has been removed by cutting or grading. The fill material is generally from adjacent areas of Cascade soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Goble and Cornelius soils and other Cascade soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is slow and available water capacity is 5 to 7.5 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Cascade soils have a water table within a depth of 30 inches during December to April. The water table is perched on the fragipan. Runoff is medium, and the hazard of erosion is moderate.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are the seasonal high water table, slow permeability, a fragipan at a depth of 20 to 30 inches, and slopes of 8 to 15 percent. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces.

Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by the seasonal high water table.

This map unit is not assigned to a capability subclass.

8D-Cascade-Urban land complex, 15 to 30 percent slopes. This complex consists of somewhat poorly drained Cascade soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on convex side slopes of broad, rolling ridgetops. Areas are generally irregular in shape and 50 to 100 acres in size. Cascade soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 25 percent of this complex are areas of Cascade soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 19 inches thick. The substratum is a dark brown, mottled, silt loam fragipan to a depth of 60 inches or more.

About 25 percent of this complex are areas of Cascade soils that have been disturbed. These soils have been covered by as much as 60 inches of fill material, or as much as 100 inches or more of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Cascade soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are about 10 percent Goble, Cornelius, and other Cascade soils.

In areas where the soils are relatively undisturbed, permeability is slow and available water capacity is 5 to 7.5 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Cascade soils have a water table within a depth of 30 inches during December to April. The water table is perched on the fragipan. Runoff is medium, and the hazard of erosion is high.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are the seasonal high water table, slow permeability, a fragipan at a depth of 20 to 30 inches, and slopes of 15 to 30 percent. Excavating during summer is difficult because of the strongly compacted fragipan. Slumping is possible in

areas of cut and fill, and additional maintenance is required for banks, roads, and building foundations. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces.

Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by the seasonal high water table.

This map unit is not assigned to a capability subclass.

9B-Cazadero silty clay loam, 0 to 8 percent slopes. This well drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in old alluvium mixed with loess and volcanic ash. Elevation is 600 to 1,500 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown silty clay loam about 16 inches thick. The subsoil is dark reddish brown silty clay loam over reddish brown silty clay to a depth of 60 inches or more.

Included with this soil in mapping are areas of Mershon, Powell, and Aschoff soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 7.5 to 9 inches. Water-supplying capacity is 22 to 24 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for timber production, farming, urban development, and wildlife habitat.

This soil is well suited to farming. In the Trout Creek area, cool nighttime temperatures and frost late in spring limit some crops in some years. The major crops are hay, pasture, berries, and vegetables. Other crops are nursery plants and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control runoff. Limiting tillage on this soil to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 172. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species include black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

The main limitations to urban development are moderately slow permeability and low strength. Dwellings and roads can be designed to offset these limitations if drainage is provided. Septic tank absorption fields do not function properly because of the moderately slow permeability. Irrigation during summer is desirable for most lawn grasses, shrubs, vines, vegetable gardens, shade trees, and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass lie.

9C-Cazadero silty clay loam, 8 to 15 percent slopes. This well drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in old alluvium mixed with loess and volcanic ash. Elevation is 600 to 1,500 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown silty clay loam about 16 inches thick. The subsoil is dark reddish brown silty clay loam over reddish brown silty clay to a depth of 60 inches or more.

Included with this soil in mapping are areas of Mershon, Powell, and Aschoff soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 7.5 to 9 inches. Water-supplying capacity is 22 to 24 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for timber production, farming, urban development, and wildlife habitat.

This soil is well suited to farming. In the Trout Creek area, cool nighttime temperatures and frost late in spring limit some crops in some years. The major crops are hay, pasture, berries, and vegetables. Other crops are nursery plants and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is most successful if done when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 172. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnish good food and cover for wildlife. Common wildlife species include black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improves the habitat.

The main limitations to urban development are the moderately slow permeability, slopes of 8 to 15 percent, and low strength. Dwellings and roads can be designed to offset these limitations if sewers are provided. Septic tank absorption fields do not function properly because of the moderately slow permeability. Irrigation during summer is desirable for most lawn grasses, shrubs, vines, vegetables, shade trees, and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

9D-Cazadero silty clay loam, 15 to 30 percent slopes. This well drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in old alluvium mixed with loess and volcanic ash. Elevation is 600 to 1,500 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown silty clay loam about 16 inches thick. The subsoil is dark reddish brown silty clay loam over reddish brown silty clay to a depth of 60 inches or more.

Included with this soil in mapping are areas of Mershon, Powell, and Aschoff soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 7.5 to 9 inches. Water-supplying capacity is 22 to 24 inches. Runoff is medium, and the hazard of erosion is high.

This soil is used for timber production, farming, urban development, and wildlife habitat.

This soil is poorly suited to farming. In the Trout Creek area, frost late in spring limits some susceptible crops in some years. The major crops are hay and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be plowed, fertilized, and planted to a cover crop in fall. Limiting slope length by stripcropping or terracing helps reduce sheet and rill erosion. Grassed waterways help control runoff. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this

pan and is more successful if done when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 172. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species include black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

The main limitations to urban development are the moderately slow permeability and low strength. Dwellings and roads can be designed to offset these limitations if sewers are provided. Septic tank absorption fields do not function properly because of the moderately slow permeability and slopes of 15 to 30 percent. Irrigation during summer is desirable for most lawn grasses, shrubs, vines, vegetables, shade trees, and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided. Mulching and fertilizing cut areas helps establish plants.

This soil is in capability subclass IVe.

9E-Cazadero silty clay loam, 30 to 60 percent slopes. This steep, well drained soil is on convex side slopes of broad, rolling ridgetops. This soil formed in old alluvium mixed with loess and volcanic ash. Elevation is 600 to 1,500 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown silty clay loam about 16 inches thick. The subsoil is dark reddish brown silty clay loam over reddish brown silty clay to a depth of 60 inches or more.

Included with this soil in mapping are areas of Mershon, Powell, and Aschoff soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 7.5 to 9 inches. Water-supplying capacity is 22 to 24 inches. Runoff is rapid, and the hazard of erosion is high.

This soil is mainly used for timber and for wildlife habitat. Some areas are used for urban development.

The vegetation is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 155 to 172. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

Because of steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species include black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improves the habitat.

The main limitations for urban development are the moderately slow permeability, low strength, and slopes of 30 to 60 percent. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Soil washing in disturbed areas can be controlled with cover crops or mulching. Mulching and fertilizing help to establish plants on cut areas where the subsoil is exposed. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass VIe.

10B-Cornelius silt loam, 3 to 8 percent slopes.
This moderately well drained soil is on remnants of terraces that have been dissected and are rolling. This soil formed in silty materials over mixed old alluvium. Elevation is 350 to 800 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam over silty clay loam about 25 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade and Delena soils and more sloping Cornelius soils. The included soils make up as much as 10 percent of this unit.

Permeability is slow. Effective rooting depth is 30 to 40 inches. Available water capacity is 6 to 8 inches. Water-supplying capacity is 18 to 20 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 30 to 48 inches from December through April.

This soil is used for farming, urban development, timber production, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, orchards, nursery stock, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and, in places to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, western hazel, willow, creambush oceanspray, roses, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, grasses, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 160 to 170. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations to timber production are the slowly permeable fragipan at a depth of 30 to 40 inches and the resultant perched water table from December through April. Some windthrow occurs in places because of restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grain, grasses, and orchard crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species include a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. The habitat can be improved by planting desirable vegetation and by protecting and managing existing vegetation.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations to urban development are the seasonal high water table, slow permeability, and 30 to 40 inch depth to the fragipan. Dwellings and roads must be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan, and drainage is required for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with shade trees, ornamental trees, shrubs, vines, and other deep-rooted plants. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. To establish plants where the surface layer has been removed and the fragipan has been exposed is difficult. Mulching and fertilizing cut areas help establish plants.

This soil is in capability subclass IIIe.

10C-Cornelius silt loam, 8 to 15 percent slopes.
This moderately well drained soil is on remnants of terraces that have been dissected and are rolling. This soil formed in silty materials over mixed old alluvium. Elevation is 350 to 800 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam over

silty clay loam about 25 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade and Delena soils and other Cornelius soils. The included soils make up as much as 10 percent of this unit.

Permeability is slow. Effective rooting depth is 30 to 40 inches. Available water capacity is 6 to 8 inches. Water-supplying capacity is 18 to 20 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is at a depth of 30 to 48 inches from December through April.

This soil is used for farming, urban development, timber production, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, orchards, nursery stock, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Deep subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and, in places to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, western hazel, willow, creambush oceanspray, roses, tall Oregon-grape, salal, swordfern, brackenfern, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 160 to 170. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations to timber production are the slowly permeable fragipan at a depth of 30 to 40 inches and the resultant perched water table during December through April. Some windthrow occurs because of restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grain, grasses, and orchard crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species include a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. The habitat can be improved by planting desirable vegetation and by protecting and managing existing vegetation.

Increased population growth has resulted in increased homesite construction on this soil. The limitations to urban development are the seasonal high water table, slow permeability, 30 to 40 inch depth to the fragipan, moderate slopes, and low strength. Dwellings and roads must be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan, and drainage is required for best results with basements and crawl spaces. Septic tank absorption fields do not functions properly during rainy periods because of wetness and slow permeability.

Drainage is required for best results with shade trees, ornamental trees, shrubs, vines, and other deep-rooted plants. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. To establish plants where the surface layer has been removed and the fragipan has been exposed is difficult. Mulching and fertilizing cut areas help establish plants.

This soil is in capability subclass IIIe.

10D-Cornelius silt loam, 15 to 30 percent slopes.

This moderately well drained soil is on remnants of terraces that have been dissected and are rolling. This soil formed in silty materials over mixed old alluvium. Elevation is 350 to 800 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam over silty clay loam about 25 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade, Delena, and other Cornelius soils. The included soils make up as much as 10 percent of this map unit.

Permeability is slow. Effective rooting depth is 30 to 40 inches. Available water capacity is 6 to 8 inches. Water-supplying capacity is 18 to 20 inches. Runoff is medium,

and the hazard of erosion is high. A water table is at a depth of 30 to 48 inches from December through April.

This soil is used for farming, urban development, timber production, and wildlife habitat.

The soil is poorly suited to farming. The major crops are hay and pasture. Irrigation during summer is required for maximum production. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized, and planted to a cover crop in fall. Limiting slope length by stripcropping or terracing helps reduce sheet and rill erosion. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Tile systems installed across the slope improves efficiency. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, willow, creambush oceanspray, common snowberry, roses, tall Oregon-grape, Pacific dogwood, western hazel, salal, swordfern, brackenfern, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 160 to 170. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations to timber production are the slowly permeable fragipan at a depth of 30 to 40 inches and the resultant perched water table from December through April. Some windthrow occurs in places because of restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grain and grasses along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species include a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. The habitat can be improved by planting desirable vegetation and by protecting and managing existing vegetation.

Increased population growth has resulted in increased homesite construction on this soil. The limitations to urban development are the seasonal high water table, slow permeability, moderately steep slopes, 30 to 40 inch depth to a fragipan, and low strength. Dwellings and roads must be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. Slumping is possible in areas of cut and fill, and because of this additional maintenance of banks, roads, and building foundations is required. A seasonal water table is perched on top of the fragipan, and drainage needs to be provided for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with shade trees, ornamental trees, shrubs, vines, and other deep-rooted plants. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. To establish plants where the surface layer has been removed and the fragipan has been exposed is difficult. Mulching and fertilizing cut areas help establish plants.

This soil is in capability subclass IVe.

11B-Cornelius-Urban land complex, 3 to 8 percent slopes. This complex consists of moderately well drained Cornelius soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on remnants of terraces that have been dissected and are rolling. Areas are generally irregular in shape and 20 to 100 acres in size. Cornelius soils and Urban land are in such an intricate pattern or so small in area that separating them in mapping was not practical. Elevation is 350 to 800 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Cornelius soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam over silty clay loam about 25 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

About 30 percent of this complex are areas of Cornelius soils that have been disturbed. These soils have been covered by as much as 20 inches of fill material, or as much as 30 inches of the original soil has been removed by cutting or grading. The fill material is generally from adjacent areas of Cornelius soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Cascade and Delena soils and other Cornelius soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is slow and available water capacity is 6 to 8 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Cornelius soils have a water table within a depth of 4 feet from December to April. The water table is perched on the fragipan. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are the moderate drainage, slow permeability, and 30 to 40 inch depth to the fragipan. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan, and drainage needs to be provided for best results with basements and crawl spaces. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal water table and droughty conditions should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

11C-Cornelius-Urban land complex, 8 to 15 percent slopes. This complex consists of moderately well drained Cornelius soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on remnants of terraces that are dissected and rolling. Areas are generally irregular in shape and 20 to 100 acres in size. Cornelius soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 350 to 800 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Cornelius soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam over silty clay loam about 25 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

About 30 percent of this complex are areas of Cornelius soils that have been disturbed. These soils have been covered by as much as 20 inches of fill material, or as much as 30 inches of the original soil has been removed by cutting or grading. The fill material is generally from adjacent areas of Cornelius soils that have been cut or graded.

About 40 percent of this complex is Urban land. In these areas, the soils are generally covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Cascade and Delena soils and other Cornelius soils. The included soils make up about 10 percent of this map unit.

In areas of this complex where the soils are relatively undisturbed, permeability is slow and available water capacity is 6 to 8 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Cornelius soils have a water table within a depth of 4 feet from December to April. The water table is perched on the fragipan. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are the moderate drainage, slow permeability, 30 to 40 inch depth to a fragipan, and slopes of 8 to 15 percent. Excavating in summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan, and drainage needs to be provided for best results with basements and crawl spaces. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal water table and droughty conditions should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

12-Cryofibrists, nearly level. These very poorly drained soils are on broad, rolling ridgetops in the eastern part of Multnomah County (fig. 7). Slopes are concave. These soils consist of partly decomposed wood, mosses, and herbaceous plants such as grasses and sedges. The soils are saturated most of the time. Depth to bedrock or cemented glacial till is 20 to 60 or more inches. Thin mineral layers, including volcanic ash, in places are below a depth of 20 inches. Elevation is 2,800 to 4,200 feet. The average annual precipitation is 70 to 135 inches, the average annual air temperature is 40 to 45 degrees F, and the frost-free period is 10 to 30 days.

Included with these soils in mapping are areas of Kinzel, Divers, Talapus, and Lastance soils and soils that are similar to Cryofibrists but are not as deep to bedrock. The included soils make up as much as 5 percent of this map unit.

These soils have poor potential for most uses. They have good potential for use as natural areas and as

Figure 7.- Cryofibrists soils in concave areas surrounded by Kinzel and Divers soils.

habitat for some kinds of wildlife. These soils also have good potential for water supply.

These soils are not assigned to a capability subclass.

13-Dabney loamy sand. This somewhat excessively drained soil is on long, narrow terraces along the lower Sandy River. This soil formed in sandy alluvium. Slopes are 0 to 3 percent. Elevation is 30 to 400 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 100 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown loamy sand and sand about 15 inches thick. The substratum is dark gray coarse and medium sand to a depth of 60 inches or more.

Included with this soil in mapping are areas of Riverwash and Haplumbrepts, moderately steep. The included soils and miscellaneous areas make up as much as 15 percent of this map unit.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is 3 to 4 inches. Water-supplying capacity is 15 to 17 inches. Runoff is very slow. The hazard of erosion is slight, and the hazard of soil blowing is high.

This soil is used for wildlife habitat, urban development, and recreational activities.

This soil is poorly suited to farming. It is limited to only a few crops unless irrigated. The low available water capacity and the severe droughty conditions in summer are hazards for shallow-rooted plants.

The vegetation is Douglas-fir, western hemlock, western redcedar, bigleaf maple, red alder, black cottonwood, willow, common snowberry, trailing blackberry, Cascade Oregon-grape, salal, brackenfern, swordfern, grasses, and forbs.

This soil is on terraces adjacent to streams and below very steep Haplumbrepts. Wildlife populations are relatively stable in these habitats. Most of the potential for wildlife habitat depends on the management of existing plant communities, but some depends on the growing of desirable vegetation. Resident and seasonal wildlife species include black-tailed deer, coyote, raccoon, skunks, foxes, opossum, rabbits, squirrels, and mice. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, and many kinds of small birds.

This soil has few limitations for homesites and other urban uses. Cut banks and other excavations are not stable, and slumping is possible. Septic tank absorption fields in places contaminate adjacent water sources because of rapid permeability in the underlying material. Soil blowing is a concern where the soil has been disturbed, but the blowing can be controlled by mulching or by seeding to grasses. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, shade trees, and ornamental trees. To establish plants in areas that have had the surface layer removed is difficult because of soil blowing and droughty conditions. Mulching and fertilizing help establish lawn grasses on cut areas.

This soil is in capability subclass Vls.

14C-Delena silt loam, 3 to 12 percent slopes. This poorly drained soil is on broad, high terraces. This soil formed in silty materials. Slopes are concave. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is mottled, very dark grayish brown silt loam about 13 inches thick. The subsoil is mottled, dark grayish brown over grayish brown silty clay loam about 10 inches thick. The substratum is a mottled, grayish brown silty clay and variegated silty clay loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade soils and other Delena soils that are steeper than this Delena soil. The included soils make up as much as 10 percent of this map unit.

Permeability is very slow. Effective rooting depth is restricted by the perched seasonal water table but ranges from 12 to 24 inches. Available water capacity is 5 to 6.5 inches. Water-supplying capacity is 17 to 18.5 inches. Runoff is slow, and the hazard of erosion is moderate. This soil is subject to frequent ponding and to a water table from 12 inches above the surface to 18 inches below the surface from December to May.

This soil is used for farming, wildlife habitat, and urban development.

This soil is poorly suited to farming. It requires extensive drainage. The major crop is pasture. Only water-tolerant grasses and legumes are suited. Drainage can be improved by ditches and tile systems that are placed to intercept ground water from higher lying areas. Tile trenches require backfilling with permeable material. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Limiting tillage to seedbed preparation and weed control helps reduce runoff and erosion. Grasses respond to nitrogen. Legumes need phosphorus and lime and in places, boron.

The vegetation in areas not cultivated is Oregon ash, western redcedar, roses, common snowberry, trailing blackberry, hawthorn, willow, grasses, sedges, and forbs.

This soil is in a fringe area between forested hills and farmland. Openland and woodland are almost equal in extent. Wildlife populations are relatively stable in these habitats. Most of the potential for wildlife habitat depends on the management of existing plant communities but some depends on the growing of desirable vegetation for food and cover. Resident and seasonal wildlife species on this soil include black-tailed deer, coyote, raccoon, skunks, foxes, opossum, rabbits, squirrels, and mice. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds.

This soil is severely limited for homesite construction and other urban uses. The main limitations to urban development are frequent ponding and poor drainage. Septic tank absorption fields do not function properly because of wetness and slow permeability. Drainage is required for proper installation of roads and building foundations. Excavating while the soil is wet is very difficult. Selection of adapted vegetation is critical for the establishment of lawns, shrubs, trees, and vegetable gardens. Only those species that can tolerate wet conditions should be used. Recreational uses are limited by the seasonal high water table and ponding.

This soil is in capability subclass IVw.

15-Faloma silt loam. This poorly drained soil is on flood plains along the Columbia River. This soil formed in mixed alluvium. Slopes are 0 to 3 percent. Elevation is 10 to 20 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil is dark gray, mottled silt loam about 5 inches thick. The substratum is variegated, mottled sand to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie, Moag, and Rafton soils. The included soils make up less than 10 percent of this map unit.

Permeability is moderate in the surface layer and subsoil and rapid in the substratum. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 15 to 20 inches. Runoff is slow, and the hazard of erosion from overflow is high. The soil is subject to frequent flooding during May and June. A water table is within a depth of 12 inches from December through June.

This soil is used for farming, wildlife habitat, and recreational activities.

This soil is very poorly suited to farming. Only those plants that can withstand prolonged inundation by flooding and a high water table for a long period are adapted. Irrigation during summer is required for maximum production. Sprinkler irrigation is suited and is commonly used. Grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime.

The native vegetation is black cottonwood, Oregon ash, willow, roses, trailing blackberry, common snowberry, forbs, and grasses.

A wide variety of vegetation grows on this soil, furnishing good food and cover for ring-necked pheasant, California quail, mourning dove, and wintering waterfowl. Other common wildlife are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, eagles, vultures, herons, jays, crows, woodpeckers, hummingbirds, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to large bodies of water, it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable species of plants and protecting existing vegetation improve the habitat.

This soil is severely limited for homesites and other urban uses. The main limitations are frequent flooding and a seasonal high water table. Recreational uses are limited by seasonal flooding and wetness.

This soil is in capability subclass Vlw.

16-Faloma silt loam, protected. This poorly drained soil is on flood plains along the Columbia River. This soil formed in mixed alluvium. Slopes are 0 to 3 percent. Elevation is 10 to 20 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The substratum is variegated, mottled coarse sand to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie, Rafton, and Moag soils. The included soils make up less than 10 percent of this map unit.

Permeability is moderate in the surface layer and subsoil and rapid in the substratum. Effective rooting depth

is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 15 to 20 inches. Runoff is slow, and the hazard of erosion is slight. This soil has a water table within a depth of 1 foot from December to June. The soil is subject to flooding but is protected by dikes and levees.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. Large areas are drained and farmed. If this soil is drained, most climatically adapted crops do well. Truck crops, nursery stock, strawberries, hay, and pasture are the major crops. Returning crop residue to the soil helps maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Irrigation is by sprinklers and is required for maximum crop production. Vegetable crops and berries respond to nitrogen, phosphorus, and potassium and in places, to sulfur. Lime is needed in places to reduce the acidity for some crops.

The vegetation in areas not cultivated is black cottonwood, Oregon ash, willow, roses, trailing blackberry, common snowberry, forbs, and grasses.

A wide variety of grasses, vegetables, and fruits along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, mourning dove, and wintering waterfowl. Other common wildlife are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, eagles, herons, jays, crows, woodpeckers, hummingbirds, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to large bodies of water, it provides good food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable species of plants and protecting existing vegetation, particularly in fence rows, improve the habitat.

This soil is severely limited for homesites and other urban uses. The main limitation for urban development is the seasonal high water table. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerant droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIw irrigated and IVw nonirrigated.

17C-Goble silt loam, 3 to 15 percent slopes. This moderately well drained soil is on rolling ridgetops. Slopes are convex. This soil formed in silty materials mixed with volcanic ash. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the frost-free period is 120 to 165 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 14 inches thick. The upper part of the subsoil is dark brown silt loam and silty clay loam about 23 inches thick. The lower part of the subsoil is a mottled, dark yellowish brown, silty clay loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade soils and steeper Goble soils. The included soils make up as much as 15 percent of this map unit. Also included in T. 1 S., R. 1 E., are areas of Goble soils, but these soils have basalt bedrock at a depth of 40 to 60 inches.

Permeability is moderate above the fragipan and slow in the fragipan. Effective rooting depth is 30 to 48 inches. Available water capacity is 8 to 10 inches. Water-supplying capacity is 20 to 22 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is within a depth of 4 feet from December through April.

This soil is used for timber production, forage crops, urban development, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Grasses respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Legumes are restricted by the short growing season and cool temperatures.

The vegetation in areas not cultivated is Douglas-fir, western hemlock, grand fir, western redcedar, red alder, bigleaf maple, red huckleberry, vine maple, western hazel, willow, thimbleberry, Cascade Oregon-grape, trailing blackberry, salal, common snowberry, roses, swordfern, and forbs, including Pacific trillium and violets.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 145 to 155. Based on a site index of 149, this soil is capable of producing about 9,920 cubic feet from a fully stocked stand of 70-year old trees, or 55,020 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the slowly permeable fragipan at a depth of 30 to 45 inches and the resultant perched water table from December through April. Some windthrow is possible because of the restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

In the mild, high rainfall areas of the Coast Range Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on clearing of the land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, skunks, weasels, raccoon, mountain

beaver, rabbits, and squirrels. Resident or seasonally abundant birds are hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Fur-bearing animals such as beaver, mink, and otter are common along larger streams. Most of the potential for wildlife habitat depends on the management of existing plant communities.

This soil has moderate limitations for homesites and other uses. The main limitations for urban development are the seasonal high water table and the slowly permeable fragipan at a depth of 30 to 48 inches. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. To establish plants in areas in which the surface layer has been removed and the fragipan exposed is difficult. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass Vle.

17D-Goble slit loam, 15 to 30 percent slopes. This moderately well drained soil is on rolling ridgetops. Slopes are convex. This soil formed in silty materials mixed with volcanic ash. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the frost-free period is 120 to 165 days.

Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper part of the subsoil is dark brown silt loam and silty clay loam about 23 inches thick. The lower part of the subsoil is a mottled, dark yellowish brown, silty clay loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade soils and other Goble soils. The included soils make up as much as 15 percent of this map unit. Also included in T. 1 S., R. 1 E., are areas of Goble soils, but these soils have bedrock at a depth of 40 to 60 inches.

Permeability is moderate above the fragipan and slow in the fragipan. Effective rooting depth is 30 to 48 inches. Available water capacity is 8 to 10 inches. Water-supplying capacity is 20 to 22 inches. Runoff is medium, and the hazard of erosion is high. A water table is within a depth of 4 feet from December through April.

This soil is used for timber production, forage crops, urban development, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Grasses respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, lime and in places, to boron. Legumes are restricted by the short growing season and cool temperatures.

Vegetation is Douglas-fir, western hemlock, grand fir, western redcedar, red alder, bigleaf maple, red huckleberry, vine maple, western hazel, willow, thimbleberry, Cascade Oregon-grape, trailing blackberry, salal, common snowberry, swordfern, and forbs, including Pacific trillium and violets.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 145 to 155. Based on a site index of 149 this soil is capable of producing about 9,920 cubic feet from a fully stocked stand of 70-year old trees, or 55,020 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, and common snowberry, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the slowly permeable fragipan at a depth of 30 to 45 inches and the resultant perched water table during December through April. Some windthrow of trees is possible because of the restricted rooting depth. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

In the mild, high rainfall areas of the Coast Range Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends upon the clearing of land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat commonly is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, skunks, weasels, raccoon, mountain beaver, rabbits, and squirrels. Resident or seasonal abundant birds are hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Fur-bearing animals such as beaver, mink, and otter are common along larger streams. Most of the potential for wildlife habitat depends on the management of existing plant communities.

This soil has moderate limitations for homesites and other uses. The main limitations for urban development are the seasonal high water table, slope, low bearing strength, and the slowly permeable fragipan at a depth of 30 to 45 inches. Excavating during summer is difficult because of the strongly compacted fragipan. Slumping is possible in areas of cut and fill, and additional maintenance of banks, roads, and building foundations is required. A seasonal water table is perched on top of the fragipan and drainage is required for best results with basements. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. To establish plants in areas in which the surface layer has been removed and the fragipan exposed is difficult. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass Vle.

17E-Goble silt loam, 30 to 60 percent slopes. This steep, moderately drained soil is on convex side slopes of ridgetops. This soil formed in silty materials mixed with volcanic ash. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the frost-free period is 120 to 165 days.

Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper part of the subsoil is dark brown silt loam and silty clay loam about 23 inches thick. The lower part of the subsoil is a mottled, dark yellowish brown, silty clay loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade and Wauld soils and other Goble soils. The included soils make up as much as 15 percent of this map unit. Also included in mapping in T. 1 S., R. 1 E., are areas of Goble soils, but these soils have basalt bedrock at a depth of 40 to 60 inches.

Permeability is moderate above the fragipan and slow in the fragipan. Effective rooting depth is 30 to 48 inches. Available water capacity is 8 to 10 inches. Water-supplying capacity is 20 to 22 inches. Runoff is rapid, and the hazard of erosion is high. A water table is within a depth of 4 feet from December through April.

This soil is used for timber production, urban development, and wildlife habitat.

Vegetation is Douglas-fir, western hemlock, grand fir, western redcedar, red alder, bigleaf maple, red huckleberry, western hazel, vine maple, willow, thimbleberry, Cascade Oregon-grape, trailing blackberry, salal, common snowberry, swordfern, and forbs, including Pacific trillium and violets.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 145 to 155. Based on a site index of 149 this soil is capable of producing about 9,920 cubic feet from a fully stocked stand of 70-year old trees, or 55,020 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species including salal, Cascade Oregon-grape, and common snowberry restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the slowly permeable fragipan at a depth of 30 to 45 inches and the resultant perched water table from December through April. Some windthrow is possible because of the restricted rooting depth. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts, fills, and skidroads. Slumping occurs on road cuts and requires additional maintenance. All-season roads on this soil need a heavy base of rock.

In the mild, high rainfall areas of the Coast Range Mountains vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential to produce wildlife, especially black-tailed deer, depends on the clearing of land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Suitable habitat is common for species such as Roosevelt elk, black bear, coyote, bobcat, skunks, weasels, raccoon, mountain beaver, rabbits, and squirrels. Resident or seasonally abundant birds are hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Fur-bearing animals such as beaver, mink, and otter are common along larger streams. Most of the potential for wildlife habitat depends on the management of existing plant communities.

Increased population growth has resulted in increased home construction on this soil. This soil has severe limitations for dwellings and roads because of steep slopes. Other limitations are the seasonal high water table, low bearing strength, and the slowly permeable fragipan at a depth of 30 to 45 inches. Excavating during summer is difficult because of the strongly compacted fragipan. Slumping is possible in areas of cut and fill, and additional maintenance of banks, roads, and building foundations is required. A seasonal water table is perched on top of the fragipan, and drainage is required for best results with basements. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. To establish plants in areas in which the surface layer has been removed and the fragipan exposed is difficult. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass Vle.

18C-Goble-Urban land complex, 3 to 15 percent slopes. This complex consists of moderately well drained Goble soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on rolling ridgetops. Slopes are convex. Areas are generally irregular in shape and 25 to 100 acres in size. The Goble soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the frost-free period is 120 to 165 days.

About 20 percent of this complex are areas of Goble soils that are relatively undisturbed. Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper part of the subsoil is dark brown silt loam and silty clay loam about 23 inches thick. The lower part of the subsoil is a mottled, dark yellowish brown, silty clay loam fragipan to a depth of 60 inches or more.

About 30 percent of this complex are areas of Goble soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Goble soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Cascade soils, other Goble soils, and soils that have basalt bedrock at a depth of 40 to 60 inches. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate above the fragipan and slow in the fragipan, and available water capacity is 8 to 10 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Goble soils have a water table within a depth of 30 to 48 inches during December to April. The water table is commonly perched on the fragipan. Runoff is medium, and the hazard of erosion is moderate.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are the seasonal high water table and the slowly permeable fragipan at a depth of 30 to 48 inches. The seasonal water table on top of the fragipan requires drainage for best results with basements.

Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. To establish plants in areas in which the surface layer has been removed and the fragipan has been exposed is difficult. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

18D-Goble-Urban land complex, 15 to 30 percent slopes. This complex consists of moderately well drained Goble soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on rolling ridgetops. Slopes are convex. Areas are generally irregular in shape and 25 to 100 acres in size. The Goble soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the frost-free period is 120 to 165 days.

About 15 percent of this complex are Goble soils that are relatively undisturbed. Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper part of the subsoil is dark brown silt loam and silty clay loam about 23 inches thick. The lower part of the subsoil is a mottled, dark yellowish brown, silty clay loam fragipan to a depth of 60 inches or more.

About 35 percent of this complex are areas of Goble soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Goble soils that have been cut or graded.

About 40 percent of the complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Cascade soils, other Goble soils, and soils that have basalt bedrock at a depth of 40 to 60 inches. The included soils make up as much as 10 percent of this unit.

In areas where the soils are relatively undisturbed, permeability is moderate above the fragipan and slow in the fragipan, and available water capacity is 8 to 10 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Goble soils have a water table within a depth of 30 to 48 inches during December to April. The water table is commonly perched on the fragipan. Runoff is medium, and the hazard of erosion is high.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations to urban development are the seasonal high water table, slowly permeable fragipan at a depth of 30 to 48 inches and slopes of 15 to 30 percent. Slumping is possible in areas of cut and fill, and additional maintenance of banks, roads, and building foundations is required. The seasonal water table requires drainage for best results with basements.

Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. To establish plants in areas in which the surface layer has been removed and the fragipan has been exposed is difficult. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

19E-Haploxerolls, steep. These well drained and moderately well drained soils are on long, narrow es-

carpments along the small streams that have cut deeply into the valley terraces. They are also on the junction of terraces with bottom lands and flood plains along major streams and rivers. These soils formed in a mixture of silt and sand and in the accumulated material from soil creep downslope. These soils have slopes of 20 to 50 percent. Slopes are short. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown and brown fine sandy loam, sandy loam, silt loam, loam, or silty clay loam 6 to 10 inches thick. The subsoil is dark yellowish brown or brown sandy loam, silt loam, loam, or silty clay loam. It has 0 to 65 percent coarse fragments. The substratum is silty or sandy and yellowish brown or brown and extends to a depth of many feet in places.

Included with these soils in mapping are areas of Latourell, Quafeno, and Quatama soils and soils that have a dark colored surface layer 10 to 15 inches thick. These soils make up as much as 20 percent of this map unit. Also included are small seep spots and wet season springs.

Permeability is moderate to moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 10 to 12 inches. Water-supplying capacity is 20 to 26 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. These soils are subject to slumping.

These soils are used for wildlife habitat, urban development, and farming.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, vine maple, western hazel, common snowberry, trailing blackberry, roses, grasses, and forbs.

These soils are around areas of farmland where the extent of openland and woodland is almost equal. A wide variety of grain and grasses along with shrubs and trees furnishes good food and cover for wildlife. Wildlife species, both resident and seasonal, on this soil include ring-necked pheasant, California quail, and mourning dove. Other common wildlife species include foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings and many other kinds of small birds. The potential for improving wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improves the habitat.

Increased population growth has resulted in increased homesite construction on these soils. The main limitation for urban development is slopes of 20 to 50 percent. Slumping occurs in areas of cut and fill, and because of this additional maintenance of banks, roads, and building foundations is required in places. Irrigation in summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

These soils are in capability subclass VIe.

20C-Haplumbrepts, moderately steep. These well drained and moderately well drained soils are on dissected mountainous terrain along the Sandy and Columbia Rivers. These soils formed in a mixture of silt and sand and in the accumulated material from downslope soil creep. These soils have slopes of 3 to 25 percent. The average annual precipitation is 10 to 90 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 160 to 200 days.

Typically, the surface layer is very dark brown or dark brown silt loam, loam, or silty clay loam 10 to 12 inches thick. The subsoil is dark yellowish brown or dark brown silt loam, loam, or silty clay loam and has as much as 65 percent pebbles or cobbles. The substratum is silty or sandy and cobbly or gravelly and extends to a depth of many feet in places.

Included with these soils in mapping are areas of Haplumbrepts, very steep; Quatama, Quafeno, Bull Run, Cazadero, and Dabney soils; and soils that are similar to Haplumbrepts but are 20 to 60 inches deep to bedrock. The included soils make up as much as 20 percent of this map unit. Also included in mapping are small seep spots and wet season springs.

Permeability is moderate to moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 3 to 12 inches. Water-supplying capacity is 20 to 26 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate. These soils are subject to slumping.

These soils are used for timber production, wildlife habitat, and homesites. They are also used for such recreational activities as picnicking, hiking, and camping.

The vegetation (fig. 8) is Douglas-fir, western hemlock, western redcedar, bigleaf maple, red alder, black cottonwood, vine maple, western hazel, willow, common snowberry, trailing blackberry, roses, Cascade Oregon-grape, salal, brackenfern, swordfern, grasses, and forbs.

These soils are suited to Douglas-fir. The site index for Douglas-fir on these soils ranges from 120 to 135. Based on a site index of 130, these soils are capable of producing about 8,600 cubic feet from a fully stocked stand of 70-year old trees, or 42,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

When these soils are wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Road cuts require additional maintenance because of slumping. All-season roads on this soil need a heavy base of rock.

These soils are in the fringe area that is transitional from the valley to forested hills. Openland and woodland are almost equal in extent. Wildlife populations are rela-

Figure 8.- A wide variety of plants in a native plant community on Haplumbrepts, moderately steep.

tively stable in these habitats. Most of the potential for wildlife habitat depends on management of existing plant communities, but some potential depends on growing desirable vegetation. Resident and seasonal wildlife species include black-tailed deer, coyote, bobcat, raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Common birds are hawks, jays, ravens, crows, vultures, woodpeckers, insect eaters, doves, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds.

These soils are severely limited for homesites and other urban uses. The main limitation for urban development is steep slopes. Slumping occurs in places in areas of cut and fill, and because of this additional maintenance of banks, roads, and building foundations is required. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

These soils are in capability subclass Vle.

20F-Haplumbrepts, very steep. These well drained and moderately well drained soils are on broken landscapes along the Sandy and Columbia Rivers. These soils formed in a mixture of silt and sand and in the accumulated material from downslope soil creep. These soils have slopes of 50 to 90 percent. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 160 to 200 days.

Typically, the surface layer is very dark brown, very dark grayish brown, or dark brown silt loam, loam, or silty clay loam 10 to 12 inches thick. The subsoil is dark yellowish brown, brown, or dark brown silt loam, loam, or silty clay loam and has as much as 65 percent pebbles or cobbles. The substratum is silty or sandy and cobbly or gravelly and extends to a depth of many feet in places.

Included with these soils in mapping are areas of Haplumbrepts, moderately steep; Aschoff, Goble, Wahkeena, Quatama, Quafeno, Cazadero, Mershon, and Dabney soils; and soils that are similar to Haplumbrepts, but are 10 to 20 inches deep to bedrock. The included soils make up as much as 20 percent of this map unit. Also included in mapping are small seep spots and wet season springs.

Permeability is moderate to moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 10 to 13 inches. Water-supplying capacity is 20 to 26 inches. Runoff is slow to rapid, and the hazard of erosion is slight to high. These soils are subject to slumping.

These soils are used for timber production and wildlife habitat. They are also used for such recreational activities as picnicking, hiking, and camping.

The vegetation is Douglas-fir, western hemlock, western redcedar, bigleaf maple, red alder, black cottonwood,

vine maple, western hazel, willow, common snowberry, trailing blackberry, blue elderberry, roses, Cascade Oregon-grape, salal, brackenfern, swordfern, grasses, and forbs.

These soils are suited to Douglas-fir. The site index for Douglas-fir on these soils ranges from 120 to 135. Based on a site index of 130, these soils are capable of producing about 8,600 cubic feet from a fully stocked stand of 70-year old trees or 42,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir.

The main limitation for timber production is steep slopes. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Road cuts need additional maintenance because of slumping. All-season roads on this soil need a heavy base of rock.

These soils are in the fringe area that is transitional from the valley to forested hills. Openland and woodland are almost equal in extent. Wildlife populations are relatively stable in these habitats. Most of the potential for wildlife habitat depends on the management of existing plant communities, but some potential depends on growing desirable vegetation. Resident and seasonal wildlife species include black-tailed deer, coyote, bobcat, raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Common birds are hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, doves, band-tailed pigeon, ruffed grouse, blue grouse, mountain quail, California quail, ring-necked pheasant, and many kinds of small birds.

These soils are severely limited for homesite construction and other urban uses. The main limitations for urban development are slopes of 50 to 90 percent and low strength. Slumping occurs in places in areas of cut and fill, and because of this additional maintenance of banks, roads, and building foundations is required. Irrigation during summer is desirable for lawn grasses, shrubs, vines, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

These soils are in capability subclass Vile.

21B-Helvetia silt loam, 3 to 8 percent slopes. This moderately well drained soil is on convex side slopes of old terraces. This soil formed in stratified old alluvium of mixed origin. Elevation is 250 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 10 inches thick. The subsoil is dark yellowish brown silty clay loam and silty clay to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade, Cornelius, Delena, and Saum soils, and more sloping Helvetia soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 19 to 21 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 3 to 6 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil against erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. Tile systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western hazel, willow, creambush oceanspray, roses, common snowberry, forbs, and grasses.

A wide variety of vegetation grows on this soil and furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, and mourning dove. Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improves the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations to urban development are the seasonal high water table,

moderately slow permeability, low strength, and clayey texture. Dwellings and roads can be designed to offset these limitations if sewers are provided. Septic tank absorption fields do not function properly in places during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIe.

22D-Kinzel-Divers-Goodlow association, moderately steep. These well drained soils are on broad ridgetops on the Cascade Mountains. They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Elevation is 2,800 to 3,600 feet. The average annual precipitation is 70 to 135 inches, the average annual air temperature is 40 to 45 degrees F, and the frost-free period is 10 to 30 days.

This association is about 40 percent Kinzel soils, 20 percent Divers soils, and 20 percent Goodlow soils. The extent of these soils may vary from one area to another. Making up as much as 20 percent of this map unit are Talapus, Lastance, and Zygore soils; Cryofibrists; Rubble land; and soils that are similar to Zygore soils but are 20 to 60 inches deep to cemented glacial till.

Typically, the Kinzel soil has a surface layer of dark brown very gravelly silt loam about 13 inches thick. The subsoil is dark brown extremely cobbly silt loam about 25 inches thick. The substratum is brown extremely cobbly loam to a depth of 60 inches or more.

Typically, the Divers soil has a surface layer of dark brown gravelly silt loam about 4 inches thick. The subsoil is brown gravelly silt loam and very cobbly loam about 40 inches thick. The substratum is dark yellowish brown extremely cobbly loam to a depth of 60 inches or more.

Typically, the Goodlow soil has a surface layer of dark brown gravelly silt loam about 10 inches thick. The subsoil is brown very cobbly clay loam about 24 inches thick. The substratum is brown extremely cobbly loam to a depth of 60 inches or more.

Permeability is moderate in the Kinzel soil. Effective rooting depth is 60 inches or more. Available water capacity is 7 to 11 inches. Water-supplying capacity is 22 to 26 inches. Runoff is medium, and the hazard of erosion is moderate.

Permeability is moderately rapid in the Divers soil. Effective rooting depth is 60 inches or more. Available water capacity is 5 to 12 inches. Water-supplying capacity is 14 to 20 inches. Runoff is medium, and the hazard of erosion is moderate.

Permeability is moderate in the Goodlow soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 5 inches. Water-supplying capacity is 20 to 25 inches. Runoff is medium, and the hazard of erosion is moderate.

These soils are mainly used for timber production, wildlife habitat, and water supply.

Vegetation is Douglas-fir, western hemlock, noble fir, Pacific silver fir, western redcedar, red alder, vine maple, blue huckleberry, beargrass, and forbs (fig. 9).

The Kinzel soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 110 to 125. Based on a site index of 118, this soil is capable of producing about 7,270 cubic feet from a fully stocked 70-year old stand, or 45,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

The main limitations of the Kinzel soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. During periods of heavy snow pack and when the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

The Divers soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 100 to 125. Based on a site index of 110, this soil is capable of producing about 6,350 cubic feet from a fully stocked stand of 70-year old trees, or 36,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

Figure 9.- Mixed stand of trees in an area of Kinzel-Divers-Goodlow association, moderately steep.

The main limitations of the Divers soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. During periods of heavy snow pack and when the soil is wet, the use of some conventional logging systems is limited. Roads and landings need protection from erosion by constructing water bars and by seeding cuts and fills.

The Goodlow soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 140 to 155. Based on a site index of 148, this soil is capable of producing about 10,370 cubic feet from a fully stocked stand of 70-year old trees, or 59,720 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 80-year old trees.

The main limitations of the Goodlow soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. Conventional logging methods are suitable for tree harvest but are restricted from November through June by climate conditions. Roads and landings need protection from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on these soils. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Resident or seasonal birds are hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on management of existing plant communities.

These soils have moderate limitations for urban development. The main limitation for urban development is the high concentration of coarse fragments. Climatic conditions are severe during winter. Plants adapted to a long, cold winter and a short, cool summer should be used in landscaping and for erosion control on cut and fill areas. Mulching and fertilizing help establish plants on disturbed areas.

This map unit is in capability subclass VIIs.

22E-Kinzel-Divers-Goodlow association, steep.

These well drained soils are on the side slopes of canyons on the Cascade Mountains. They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Elevation is 2,800 to 3,600 feet. The average annual precipitation is 70 to 135 inches, the average annual air temperature is 40 to 45 degrees F, and the frost-free period is 10 to 30 days.

This association is about 40 percent Kinzel soils, 20 percent Divers soils, and 20 percent Goodlow soils. The extent of these soils may vary from one area to another. Most areas of the Goodlow soils are in the Larch Mountain area on fans and foot slopes. Making up as much as 20 percent of this map unit are Talapus, Lastance, and Zygore soils, Rubble land, and soils that are similar to Zygore soils but are 20 to 60 inches deep to cemented glacial till.

Typically, the Kinzel soil has a surface layer of dark brown very gravelly silt loam about 13 inches thick. The subsoil is dark brown extremely cobbly silt loam about 25 inches thick. The substratum is brown extremely cobbly loam to a depth of 60 inches or more.

Typically, the Divers soil has a surface layer of dark brown gravelly silt loam about 4 inches thick. The subsoil is brown gravelly silt loam and very cobbly loam about 40 inches thick. The substratum is dark yellowish brown extremely cobbly loam to a depth of 60 inches or more.

Typically, the Goodlow soil has a surface layer of dark brown gravelly silt loam about 10 inches thick. The subsoil is brown very cobbly clay loam about 24 inches thick. The substratum is brown extremely cobbly loam to a depth of 60 inches or more.

Permeability is moderate in the Kinzel soil. Effective rooting depth is 60 inches or more. Available water capacity is 7 to 11 inches. Water-supplying capacity is 22 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

Permeability is moderately rapid in the Divers soil. Effective rooting depth is 60 inches or more. Available water capacity is 5 to 12 inches. Water-supplying capacity is 14 to 20 inches. Runoff is rapid, and the hazard of erosion is high.

Permeability is moderate in the Goodlow soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 5 inches. Water-supplying capacity is 20 to 25 inches. Runoff is rapid, and the hazard of erosion is high.

These soils are mainly used for timber production, wildlife habitat, and water supply.

Vegetation is Douglas-fir, western hemlock, noble fir, western redcedar, vine maple, blue huckleberry, beargrass, and forbs.

The Kinzel soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 110 to 125. Based on a site index of 118, this soil is capable of producing about 7,270 cubic feet from a fully stocked 70-year old stand, or 45,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

The main limitations of the Kinzel soil for timber production are the cold soil temperatures, acid soil conditions, steep slopes, and high content of coarse fragments. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvest. During periods of heavy snow pack and

when the soil is wet, logging is restricted in areas. Roads and landings need protection from erosion by constructing water bars and by seeding cuts and fills.

The Divers soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 100 to 125. Based on a site index of 110, this soil is capable of producing about 6,350 cubic feet from a fully stocked 70-year old stand, or 36,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

The main limitations of the Divers soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. During periods of heavy snow pack and when the soil is wet, logging is restricted. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

The Goodlow soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 140 to 155. Based on a site index of 148, this soil is capable of producing about 10,370 cubic feet from a fully stocked 70-year old stand, or 59,720 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 80-year old trees.

The main limitations of the Goodlow soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. Because of the steep slopes, aerial, high-lead or skyline methods of logging should be used for tree harvest. During periods of heavy snow pack and when the soil is wet, logging is restricted.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on these soils. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and on the availability of new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Resident or seasonal birds are hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

These soils have severe limitations for urban development. The main limitations for urban development are steep slopes and the high concentration of coarse fragments. Climatic conditions are severe during winter.

Plants adapted to a long, cold winter and a short, cool summer should be used in landscaping and for erosion control on cut and fill areas. Mulching and fertilizing help establish plants on disturbed areas.

This map unit is in capability subclass VIIs.

23F-Kinzel-Lastance-Rubble land association, very steep. These well drained soils are on steep side slopes of canyons on the Cascade Mountains (fig. 10). They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Elevation is 2,800 to 4,000 feet. The average annual precipitation is 70 to 135 inches, the average annual air temperature is 38 to 45 degrees F, and the frost-free period is 10 to 30 days.

This association is about 40 percent Kinzel soils, 20 percent Lastance soils, and 20 percent Rubble land. The extent of these soils may vary from one area to another. The Lastance soils generally are at an elevation of 3,500 feet or more. Making up as much as 20 percent of this map unit are Talapus and Divers soils and soils that are 20 to 60 inches deep to cemented glacial till or bedrock.

Typically, the Kinzel soil has a surface layer of dark brown very gravelly silt loam about 13 inches thick. The subsoil is dark brown extremely cobbly silt loam about 25 inches thick. The substratum is brown extremely cobbly loam to a depth of 60 inches or more.

Typically, the Lastance soil has a surface layer of gray stony fine sandy loam about 1 inch thick. The subsoil is dusky red over dark brown gravelly or very cobbly fine sandy loam about 11 inches thick. The substratum is brown extremely gravelly fine sandy loam to a depth of 60 inches or more.

Typically, 90 percent or more of the surface of Rubble land is covered with cobbles, stones, and boulders. Very little if any fine earth material is exposed. The substratum is 90 percent or more cobbles, stones, and boulders and has too little fine earth material to fill the interstices between the coarse fragments.

Permeability is moderate in the Kinzel soil. Effective rooting depth is 60 inches or more. Available water capacity is 7 to 11 inches. Water-supplying capacity is 22 to 26 inches. Runoff is rapid, and the hazard of erosion is high.

Permeability is moderately rapid in the Lastance soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is rapid, and the hazard of erosion is high.

These soils are mainly used for timber production, wildlife habitat, and water supply.

Vegetation is Douglas-fir, noble fir, Pacific silver fir, western hemlock, western redcedar, red alder, blue huckleberry, vine maple, beargrass, and forbs.

The Kinzel soil is suited to Douglas-fir, western hemlock, and noble fir. The site index for Douglas-fir on this soil ranges from 110 to 125. Based on a site index of

Figure 10.- Kinzel-Lastance-Rubble land association, very steep, on canyon side slopes in areas of the Cascade Mountains.

118, this soil is capable of producing about 7,270 cubic feet from a fully stocked 70-year old stand, or 45,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

The main limitations of the Kinzel soil for timber production are the cold soil temperatures, acid soil conditions, slopes of 50 to 90 percent, and high content of coarse fragments. Because of the steep slopes, such logging methods as aerial, high-lead or skyline should be used for tree harvesting. During periods of heavy snow pack and when the soil is wet, logging is restricted. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

The Lastance soil is suited to noble fir. The site index for noble fir on this soil ranges from 50 to 70. Based on a site index of 52, this soil is capable of producing about 3,700 cubic feet from a fully stocked 70-year old stand, or 14,300 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

The main limitations of the Lastance soil for timber production are the cold soil temperatures, acid soil conditions, slopes of 50 to 90 percent, and high content of coarse fragments. Because of the steep slopes, such logging methods as aerial, high-lead or skyline should be used for tree harvesting. During periods of heavy snow pack and when the soil is wet, logging is restricted. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas on western foot slopes of the Cascade Mountains, vegetation grows rapidly on these soils. Various shrubs, grasses, and forbs are somewhat limited above an elevation of 3,600 feet. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and on the availability of

new growth of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Resident or seasonal birds are hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

These soils have severe limitations for urban development. The main limitations for urban development are slopes of 50 to 90 percent and the high concentration of coarse fragments. Climatic conditions are severe during winter. Plants adapted to a long, cold winter and a short, cool summer should be used in landscaping and for erosion control on cut and fill areas. Mulching and fertilizing help establish plants on disturbed areas.

This map unit is in capability subclass VIIs.

24D-Lastance stony fine sandy loam, 5 to 30 percent slopes. This well drained soil is on broad ridgetops in steep mountainous areas. This soil formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Elevation is 3,300 to 4,000 feet. The average annual precipitation is 110 to 135 inches, the average annual air temperature is 40 to 45 degrees F, and the frost-free period is less than 30 days.

Typically, the surface layer is gray stony fine sandy loam about 1 inch thick. The subsoil is about 11 inches thick. It is dusky red gravelly fine sandy loam over dark brown gravelly or very cobbly fine sandy loam. The substratum is brown extremely gravelly fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Kinzel and Talapus soils, other Lastance soils, Rubble land, and soils that are similar to this Lastance soil but are 20 to 40 inches deep to cemented glacial till or bedrock. The included soils and miscellaneous areas make up as much as 20 percent of this unit.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is mainly used for timber, wildlife habitat, and water supply.

Vegetation is noble fir, western hemlock, Douglas-fir, blue huckleberry, rhododendron, beargrass, and forbs.

This soil is suited to noble fir and western hemlock. The site index for noble fir on this soil ranges from 50 to 70. Based on a site index of 52, this soil is capable of producing about 3,700 cubic feet from a fully stocked stand of 70-year old trees, or 14,300 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 100-year old trees.

The main limitations for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. During periods of heavy snow pack and when the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

A limited variety of trees, shrubs, grasses, and forbs grow in areas of high precipitation and high elevations on the western slopes of the Cascade Mountains. Vegetational stages change dramatically as a result of clear-cut logging and fires. Because of cold soil temperatures, plant recovery and growth is slower than at a low elevation.

The potential for wildlife, especially black-tailed deer, depends upon openings created by clear-cutting or by other means and on the new plant growth that develops. Species of common wildlife are black bear, cougar, bobcat, coyote, marten, coney, rabbits, squirrels, and chipmunks. Birdlife includes blue grouse, ravens, hawks, owls, Clark's nutcracker, jays, wrens, and various small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities. The ecosystem on this soil is fragile, and recovery from drastic changes is very slow.

This soil has moderate limitations for urban development. The main limitation for urban development is the high concentration of coarse fragments. Climatic conditions are severe during winter. Plants adapted to a long, cold winter and a short, cool summer should be used in landscaping and for erosion control on cut and fill areas. Mulching and fertilizing help establish plants on disturbed areas.

This soil is in capability subclass VIIs.

24E-Lastance stony fine sandy loam, 30 to 60 percent slopes. This well drained soil is in steep mountainous areas. This soil formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Slopes are convex. Elevation is 3,300 to 4,000 feet. The average annual precipitation is 110 to 135 inches, the average annual air temperature is 40 to 45 degrees F, and the frost-free period is less than 30 days.

Typically, the surface layer is gray stony fine sandy loam about 1 inch thick. The subsoil is about 11 inches thick. It is dusky red gravelly fine sandy loam over dark brown gravelly or very cobbly fine sandy loam. The substratum is brown extremely gravelly fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Kinzel and Talapus soils, other Lastance soils, Rubble land, and soils that are similar to this Lastance soil but are 20 to 40 inches deep to cemented glacial till or bedrock. The included soils make up as much as 20 percent of this unit.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is rapid, and the hazard of erosion is high.

This soil is mainly used for timber, wildlife habitat, and water supply.

Vegetation is noble fir, western hemlock, Douglas-fir, blue huckleberry, rhododendron, beargrass, and forbs.

This soil is suited to noble fir and western hemlock. The site index for noble fir on this soil ranges from 50 to 70. Based on a site index of 52, this soil is capable of producing about 3,700 cubic feet from a fully stocked stand of 70-year old trees, or 14,300 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked even-aged stand of 100-year old trees.

The main limitations for timber production are cold soil temperatures, steep slopes, acid soil conditions, and high content of coarse fragments. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. During periods of heavy snow pack and when the soil is wet, logging is restricted. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

A limited variety of trees, shrubs, grasses, and forbs grow in areas of high precipitation and high elevations on the western slopes of the Cascade Mountains. Vegetational stages change dramatically as a result of clear-cut logging and fires. Because of the cold soil temperatures, plant recovery and growth is slower than at a low elevation.

The potential for wildlife, especially black-tailed deer, depends upon openings created by clear-cutting or by other means and on the new growth that develops. Species of common wildlife are black bear, cougar, bobcat, coyote, marten, coney, rabbits, squirrels, and chipmunks. Birdlife includes blue grouse, ravens, hawks, owls, Clark's nutcracker, jays, wrens, and various small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities. The ecosystem on this soil is fragile, and recovery from drastic changes is very slow.

This soil has severe limitations for urban development. The main limitations for urban development are steep slopes and the high concentration of coarse fragments. Climatic conditions are severe during winter. Plants adapted to a long, cold winter and a short, cool summer should be used in landscaping and for erosion control on cut and fill areas. Mulching and fertilizing help establish plants on disturbed areas.

This soil is in capability subclass VIIs.

25A-Latourell loam, 0 to 3 percent slopes. This well drained soil is on broad terraces. This soil formed in medium textured alluvium. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Multnomah, Powell, Burlington, and Quafeno soils and more steeply sloping Latourell soils. The included soils make up as much as 10 percent of this unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 12 inches. Water-supplying capacity is 22 to 26 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is irrigated, most climatically adapted crops do well. The major crops are vegetable and fruit crops, nursery stock, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Areas used for vegetable crops, orchards, and berries should be fertilized and planted to a cover crop or green-manure crop in fall.

Excessive cultivation of this soil results in the formation of a tillage pan in places. This pan can be broken by subsoiling when the soil is dry. Crops can be irrigated by sprinkler to increase crop production in dry periods in summer. Water needs to be applied at rates low enough to prevent runoff. Berries and vegetables respond to nitrogen, phosphorus, and potassium and, in places, to sulfur and boron. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, sulfur, boron, and lime. Orchard trees respond to nitrogen and potassium and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased homesite construction on this soil. Homesites or other urban uses have no major limitation. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability class I.

25B-Latourell loam, 3 to 8 percent slopes. This well drained soil is on broad terraces. This soil formed in

medium textured alluvium. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Multnomah, Powell, Burlington, Quafeno soils and more steeply sloping Latourell soils. The included soils make up as much as 10 percent of this unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 12 inches. Water-supplying capacity is 22 to 26 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is irrigated, most climatically adapted crops do well. The major crops are fruit crops, vegetables, nursery stock, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare in winter it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in the formation of a tillage pan in this soil. This pan can be broken by subsoiling when the soil is dry. Berries and vegetables respond to nitrogen, phosphorus, and potassium and in some places, to sulfur and boron. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, sulfur, boron, and lime. Orchard trees respond to nitrogen and potassium and in places, to boron. Sprinkler irrigation can be used to increase crop production in dry periods of summer. Water needs to be applied slowly to prevent runoff.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased homesite construction on this soil. Homesites or other urban uses have no major limitations. Some uses are restricted in places by slopes of 3 to 8 percent. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees.

This soil is in capability subclass IIe.

25C-Latourell loam, 8 to 15 percent slopes. This well drained soil is on convex side slopes of broad terraces. This soil formed in medium textured alluvium. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Multnomah, Powell, Burlington, and Quafeno soils and other Latourell soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 12 inches. Water-supplying capacity is 22 to 26 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. Most climatically adapted crops do well. The major crops are vegetables, fruit crops, nursery stock, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil, and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Deep subsoiling is required to break up this pan and is most successful if used when the soil is dry. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine

maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees are grown on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased homesite construction on this soil. The main limitation for homesites and other urban uses is slopes of 8 to 15 percent. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Soil washing on cut and fill areas can be controlled by planting grasses or by mulching. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

25D-Latourell loam, 15 to 30 percent slopes. This well drained soil is on convex side slopes of broad terraces. This soil formed in medium textured alluvium. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Multnomah, Powell, Burlington, and Quafeno soils and less steeply sloping Latourell soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 12 inches. Water supplying capacity is 22 to 26 inches. Runoff is medium, and the hazard of erosion is high.

This soil is used for farming, urban development, and wildlife habitat.

This soil has poor suitability for farming. The major crops are hay and pasture. Irrigation during summer is required for maximum production. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare in winter, it should be fertilized and planted to a cover crop in fall. Limiting slope length by stripcropping or terracing helps reduce sheet and rill erosion. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry rather than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased homesite construction on this soil. The main limitation for homesites and other urban uses is slopes of 15 to 30 percent. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Soil washing on cut and fill areas can be controlled by planting grasses or by mulching. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IVe.

26A-Latourell-Urban land complex, 0 to 3 percent slopes. This complex consists of well drained Latourell soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad terraces that have long, convex slopes. Areas are generally irregular in shape and 20 to 100 acres in area. The Latourell soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Latourell soils that are relatively undisturbed. Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

About 30 percent of this complex are areas of Latourell soils that have been disturbed. These soils have been

covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Latourell soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Multnomah, Powell, and Burlington soils and more steeply sloping Latourell soils. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 8 to 12 inches. In areas dominated by cuts, fills, and urban land, permeability and available water capacity are variable. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban uses. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

26B-Latourell-Urban land complex, 3 to 8 percent slopes. This complex consists of well drained Latourell soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad terraces that have long, convex slopes. Areas are generally irregular in shape and 20 to 100 acres in size. Latourell soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Latourell soils that are relatively undisturbed. Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

About 30 percent of this complex are areas of Latourell soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Latourell soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Multnomah, Powell, and Burlington soils and more steeply sloping Latourell soils. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 8 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban uses. Some uses are restricted by slopes of 3 to 8 percent. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

27B-Mershon silt loam, 0 to 8 percent slopes. This moderately well drained soil is on broad, rolling ridgetops. This soil formed in loess and medium textured old alluvium. Elevation is 450 to 1,300 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 200 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is brown and dark brown silt loam about 41 inches thick. The substratum is dark brown loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cazadero soils; Haplumbrepts, moderately steep; more steeply sloping Mershon soils; soils that have more than 35 percent coarse fragments; and soils that are similar to this Mershon soil and are well drained. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 11 to 13 inches. Water-supplying capacity is 22 to 24 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 3 to 5 feet from November through April.

This soil is used for farming, urban development, timber production, and wildlife habitat.

This soil is well suited to farming. The major crops are hay and pasture. Other crops are berries and vegetables. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler

irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grasses respond to nitrogen. Legumes respond to phosphorus, sulfur, boron, and lime. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 120 to 135. Based on a site index of 130, this soil is capable of producing about 8,600 feet from a fully stocked stand of 70-year old trees, or 42,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees.

Trees on this soil are subject to damage by ice breakage and wind blasting (fig. 11). Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder restrict natural regeneration of Douglas-fir. When the soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

Figure 11.- Windblast damage to Douglas-fir on Mershon silt loam, 0 to 8 percent slopes.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnishes food and cover for wildlife. Common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

The main limitations for urban development are a seasonal high water table and low strength. Dwellings and roads can be designed to offset these limitations if sewers are provided. Septic tank absorption fields in places do not function properly during rainy periods because of wetness and the moderately slow permeability. Irrigation during summer is desirable for best results with lawn grasses, shrubs, vines, vegetables, and shade and ornamental trees. To establish plants in areas in which the surface layer has been removed and the subsoil has been exposed is difficult. Mulching and fertilizing these areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

27C-Mershon silt loam, 8 to 15 percent slopes.

This moderately well drained soil is on broad, rolling ridgetops. This soil formed in loess and medium textured old alluvium. Elevation is 450 to 1,300 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost free period is 165 to 200 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is brown and dark brown silt loam about 41 inches thick. The substratum is dark brown loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cazadero soils; Haplumbrepts, moderately steep; soils that have more than 35 percent coarse fragments; soils that are similar to this Mershon soil and are well drained; and other Mershon soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 11 to 13 inches. Water-supplying capacity is 22 to 24 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is at a depth of 3 to 5 feet from November through April.

This soil is used for farming, urban development, timber production, and wildlife habitat.

This soil is suited to farming. The major crops are hay and pasture. Other crops are berries and vegetables. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is

to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grasses respond to nitrogen. Legumes need phosphorus, sulfur, boron, and lime. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, roses, western hazel, blue elderberry, creambush oceanspray, trailing blackberry, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 120 to 135. Based on a site index of 130, this soil is capable of producing about 8,600 cubic feet from a fully stocked stand of 70-year old trees, or 42,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees.

Trees on this soil are subject to damage by ice breakage and wind blasting. Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder, restrict natural regeneration of Douglas-fir. When this soil is wet, the use of some conventional logging methods is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

The main limitations for urban development are the seasonal high water table, low strength, and slope. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Irrigation during summer is desirable for best results with lawn grasses, shrubs, vines, vegetables, and shade and ornamental trees. To establish plants in areas in which the surface layer has been removed and the subsoil has been exposed is difficult. Mulching and fertilizing these areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

27D-Mershon silt loam, 15 to 30 percent slopes. This moderately well drained soil is on broad, rolling ridgetops. This soil formed in loess and medium textured old alluvium. Elevation is 450 to 1,300 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 200 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is brown and dark brown silt loam about 41 inches thick. The substratum is dark brown loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cazadero soils; Haplumbrepts, moderately steep; soils that have more than 35 percent coarse fragments; soils that are similar to this Mershon soil and are well drained; and other Mershon soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is more than 60 inches. Available water capacity is 11 to 13 inches. Water-supplying capacity is 22 to 24 inches. Runoff is medium, and the hazard of erosion is high. A water table is at a depth of 3 to 5 feet from November through April.

This soil is used for timber production, urban development, farming, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Irrigation during summer is required for maximum production. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Limiting slope length by stripcropping or terracing helps reduce sheet and rill erosion. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Tile systems are installed across the slope to intercept ground water. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, red alder, bigleaf maple, vine maple, willow, brackenfern, common snowberry, western hazel, blue elderberry, cream oceanspray, trailing blackberry, roses, and western redcedar.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 120 to 135. Based on a site index of 130, this soil is capable of producing about 8,600 cubic feet from a fully stocked stand of 70-year old trees, or 42,600 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees.

Trees on this soil are subject to damage by ice breakage and wind blasting. Brushy species, including vine maple, willow, western hazel, common snowberry, bigleaf maple, and red alder (fig. 12) restrict natural regeneration of Douglas-fir. When the soil is wet, the use of some conventional logging systems is limited. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a heavy base of rock.

A wide variety of grasses, forbs, fruits, and vegetables along with many shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for wildlife. Common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes ring-necked pheasant, California quail, mountain quail, ruffed grouse, hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, blackbirds, larks, starlings, and many kinds of small birds: The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Figure 12.- Red alder invading conifer sites after harvest on Mershon silt loam, 15 to 30 percent slopes.

The main limitations for urban development are the seasonal high water table, low strength, and slope. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness, steep slopes, and moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IVe.

28-Moag silty clay loam, protected. This very poorly drained soil is on broad flood plains of the Columbia River. This soil formed in recent alluvium with some mixing of volcanic ash. Elevation is 10 to 20 feet. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown, mottled silty clay loam about 10 inches thick. The subsoil is dark grayish brown and dark gray, mottled silty clay about 27 inches thick. The substratum is dark grayish brown silty clay to a depth of 60 inches or more.

Included with this soil in mapping are areas of Rafton and Sauvie soils. The included soils make up as much as 10 percent of this map unit.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is 9 to 12 inches. Water-supplying capacity is 21 to 25 inches. Runoff is very slow, and, the hazard of erosion is slight. The soils are protected from flooding by dikes and levees but are subject to frequent ponding from December to April. A water table is 2 feet above the surface to 12 inches below the surface from December through April (fig. 13).

This soil is used for farming and wildlife habitat.

This soil is well suited to farming. Large areas have been drained and are farmed. If this soil is artificially drained and is protected from flooding late in spring and early in summer, most climatically adapted crops do well. Perennial crops that withstand ponding during winter are adapted. The major crops are sweet corn, row crops, and spring barley. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used. Irrigation can be used to increase crop production in dry periods in summer. Grain and grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime.

The vegetation in areas not cultivated is black cottonwood, willow, roses, common snowberry, sedges, cattails, and grasses.

Figure 13.- Ponding on Moag silty clay loam.

A wide variety of grain, grasses, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, and mourning dove. Where this soil is ponded, it is excellent for wintering waterfowl. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, herons, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to larger bodies of water, it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. This soil has numerous areas that when not drained provide small ponds which can be managed for waterfowl.

This soil is severely limited for homesites and other urban uses. The main limitations for urban development are frequent ponding, high shrink-swell potential, and slow permeability.

This soil is in capability subclass IIIw.

29A-Multnomah silt loam, 0 to 3 percent slopes.

This well drained soil is on broad, convex terraces. This soil formed in stratified gravelly or cobbly alluvium. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this, to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

Included with this soil in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and more steeply sloping Multnomah silt loam. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is about 40 inches. Available water capacity is 4 to 6 inches. Water-supplying capacity is 17 to 19 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, nursery crops, urban development, and wildlife habitat.

This soil is well suited to farming. Most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, vegetables, nursery stock, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is wet than when dry. Sprinkler irrigation can be used to increase crop production in dry periods in summer.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees grow in this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are foxes, skunks, raccoons, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased urban development on this soil. Homesites and most other urban uses have no major limitations. Septic tank absorption fields contaminate ground water sources in places because of very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. In places in disturbed areas, landscaping requires removal of pebbles and cobbles. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIs.

29B-Multnomah silt loam, 3 to 8 percent slopes.

This well drained soil is on broad, convex terraces. This soil formed in stratified gravelly and cobbly alluvium. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this, to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

Included with this soil in mapping are areas of gravelly Multnomah soils, Latourell and Powell soils, and other Multnomah silt loam soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is about 40 inches. Available water capacity is 4 to 6 inches. Water-supplying capacity is 17 to 19 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for farming, nursery crops, urban development, and wildlife habitat.

This soil is well suited to farming. Most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, vegetables, nursery stock, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil against erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grains, grasses, fruits, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnish good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased urban development on this soil. Homesites and most other urban uses have no major limitations. Some uses are restricted by slopes of 3 to 8 percent in places. In places, septic tank absorption fields contaminate ground water sources because of the very rapid permeability of the underlying gravel. Disturbed areas require planting to cover or mulching to prevent washing. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. In places in disturbed areas, landscaping requires removal of pebbles and cobbles. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

29C-Multnomah silt loam, 8 to 15 percent slopes. This well drained soil is on broad, convex terraces. This soil formed in stratified gravelly or cobbly alluvium. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this, to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

Included with this soil in mapping are areas of gravelly Multnomah soils, Latourell and Powell soils, and less steeply sloping Multnomah silt loam soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is about 40 inches. Available water capacity is 4 to 6 inches. Water-supplying capacity is 17 to 19 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for farming, nursery crops, urban development, and wildlife habitat.

This soil is well suited to farming. Most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, vegetables, nursery stock, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for homesites and other urban uses is slopes of 8 to 15 percent. In places, septic tank absorption fields contaminate ground water sources because of the very rapid permeability in the underlying gravel. Disturbed areas require planting to cover or mulching to prevent washing. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. In places in disturbed areas, landscaping requires removal of pebbles and stones. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

29D-Multnomah silt loam, 15 to 30 percent slopes. This well drained soil is on broad, convex terraces. This soil formed in stratified gravelly or cobbly alluvium. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this, to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

Included with this soil in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and less steeply sloping Multnomah silt loam soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is about 40 inches. Available water capacity is 4 to 6 inches. Water-supplying capacity is 17 to 19 inches. Runoff is medium, and the hazard of erosion is high.

This soil is used for farming, urban development, and wildlife habitat.

This soil is poorly suited to farming. The major crops are hay and pasture. Irrigation during summer is required for maximum production. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping systems help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Limiting slope length by stripcropping or terracing helps reduce sheet and rill erosion. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. Coarse fragments in the surface layer are a concern to tillage in places. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitation for homesites and most other urban uses is slopes of 15 to 30 percent. In places, septic tank absorption fields contaminate ground water sources because of the very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. In places in disturbed areas, landscaping requires removal of pebbles and cobbles. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IVe.

29E-Multnomah silt loam, 30 to 60 percent slopes. This steep, well drained soil is on side slopes of broad terraces. This soil formed in stratified gravelly or cobbly alluvium. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown gravelly silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

Included with this soil in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and other Multnomah silt loam soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderate. Effective rooting depth is about 40 inches. Available water capacity is 4 to 6 inches. Water-supplying capacity is 17 to 19 inches. Runoff is rapid, and the hazard of erosion is high.

This soil is mainly used for urban development and wildlife habitat.

The vegetation is Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, vine maple, western hazel, common snowberry, trailing blackberry, creambush oceanspray, roses, grasses, and forbs.

This soil is along a fringe area adjacent to cropland. Areas have a mixture of openland and woodland. A wide variety of grain, grasses, fruits, and vegetables along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and mourning dove. Other common wildlife species are foxes, skunks, raccoon, opossum, squirrels, rabbits, and mice. Birdlife includes hawks, owls, jays, crows, hummingbirds, robins, woodpeckers, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation, particularly in fence rows, improve the habitat.

The main limitation for homesites and other urban uses is slopes of 30 to 60 percent. Some uses are limited by coarse fragments in the surface layer. Disturbed areas require planting to grasses and mulching to prevent washing during winter. For best results in landscaping in disturbed areas, particularly areas utilized for lawns, the removal of pebbles and cobbles is required. The rapidly permeable substratum is a hazard to pollution of ground water in places where subsurface sewage disposal systems are used.

This soil is in capability subclass Vle.

30A-Multnomah-Urban land complex, 0 to 3 percent slopes. This complex consists of well drained Multnomah soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad, convex terraces. Areas are g6nerally irregular in shape and 25 to 100 acres in size. The Multnomah soils and Urban land are in such an intricate

pattern or so small in area that to separate them in mapping was not practical. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Multnomah soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this, to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

About 30 percent of this complex are areas of Multnomah soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Multnomah and Latourell soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and more steeply sloping Multnomah silt loams. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 4 to 6 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. The lower part of the substratum in undisturbed areas ranges from very gravelly to extremely gravelly sand and has very rapid permeability and very low water-holding capacity. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban development. In places, septic tank absorption fields contaminate ground water sources because of very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Landscaping requires the removal of pebbles and cobbles in disturbed areas in places. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

30B-Multnomah-Urban land complex, 3 to 8 percent slopes. This complex mainly consists of well drained Multnomah soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad, convex terraces. Areas are generally irregular in shape and 25 to 100 acres in size. Multnomah soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches. The average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Multnomah soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The upper 14 inches of the substratum is dark yellowish brown gravelly silt loam. Below this, to a depth of 60 inches or more, the substratum is very dark grayish brown, dark brown, and brown very gravelly sand.

About 30 percent of this complex are areas of Multnomah soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Multnomah and Latourell soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and Multnomah silt loam, 0 to 3 percent slopes. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate in the upper part of the profile and is very rapid in the lower part of the substratum. Available water capacity is 4 to 6 inches in the relatively undisturbed areas. In areas dominated by cuts and fills, permeability and available water capacity are generally variable. The lower part of the substratum in places in undisturbed areas ranges from very gravelly to extremely gravelly sand and has very low water-holding capacity. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for most urban development. Some uses are restricted in places by slopes of 3 to 8 percent. In places, septic tank absorption fields can contaminate ground water sources because of very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Landscaping requires removal of pebbles and cobbles in places in disturbed areas. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

31-Pilchuck sand. This excessively drained soil is on flood plains of the Columbia River. This soil formed in sandy alluvium or dredge spoils. Slopes are 0 to 3 per-

cent. Elevation is 10 to 30 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown sand about 12 inches thick. The substratum is dark grayish brown sand to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie, Moag, Faloma, and Rafton soils. The included soils make up as much as 10 percent of this map unit.

Permeability is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is 3 to 6 inches. Water-supplying capacity is 10 to 15 inches. Runoff is slow, and the hazard of erosion from overflow is high. The hazard of soil blowing is moderate. This soil is subject to frequent flooding from November through April. A water table is at a depth of 2 to 4 feet from November through April.

This soil is used for grazing and wildlife habitat. It is also used for such recreational activities as picnicking, hiking, and camping.

This soil is very poorly suited to farming. It has low available water capacity and is subject to severe summer drought for shallow-rooted plants. Only those crops that can withstand prolonged inundation by flooding and periods of droughty conditions are adapted.

In areas where vegetation has become established, black cottonwood, willow, trailing blackberry, forbs, and grasses are dominant.

A limited variety of vegetation grows on this soil, providing limited food for ring-necked pheasant, California quail, bobwhite quail, mourning dove, and wintering waterfowl. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to large bodies of water it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitation for wildlife habitat is droughtiness.

This soil is severely limited for urban development. The main limitations are frequent flooding, the seasonal high water table, soil blowing, and droughtiness.

This soil is in capability subclass Vlw.

32-Pilchuck sand, protected. This excessively drained soil is on flood plains of the Columbia River. This soil formed in sandy alluvium or dredge) spoils. Slopes are 0 to 3 percent. Elevation is 10 to 30 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown sand about 12 inches thick. The substratum is dark grayish brown sand to a depth of 60 inches or more..

Included with this soil in mapping are areas of Sauvie, Moag, Faloma, and Rafton soils. The included soils make up as much as 10 percent of this map unit.

Permeability is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is 3 to 6 inches. Water-supplying capacity is 10 to 15 inches. Runoff is slow, and the hazard of soil blowing is moderate. This soil is subject to flooding but is protected by dikes and levees. A water table is at a depth of 2 to 4 feet from November through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is very poorly suited to farming. It has low available water capacity and is subject to severe summer drought for shallow-rooted plants. Unless this soil is irrigated, only those crops that can withstand prolonged periods of droughty conditions are adapted. Irrigation is required for maximum crop production. Returning crop residue to the soil helps maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall to prevent soil blowing. Grass crops respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime.

In areas where vegetation has become established, black cottonwood, willow, trailing blackberry, forbs, and grasses are dominant.

A limited variety of vegetation grows on this soil, providing limited food for ring-necked pheasant, California quail, bobwhite quail, mourning dove, and wintering waterfowl. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil. is adjacent to large bodies of water, it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitation for wildlife habitat is droughtiness.

The main limitations for urban development are soil blowing, droughtiness, and a seasonal high water table. Cut banks and other excavations are not stable, and slumping is a concern. Soil blowing is a concern in disturbed areas, but mulching helps reduce this hazard. In places, septic tank absorption fields contaminate adjacent water sources because of the rapid permeability. Irrigation during summer is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. To establish plants in disturbed areas is difficult. Mulching, fertilizing, and irrigation are needed to establish lawn grasses and other small-seeded plants.

This map unit is in capability subclass IVs.

33A-Pilchuck-Urban land complex, 0 to 3 percent slopes. This complex consists of excessively drained soil on flood plains of the Columbia and Willamette Rivers. This soil formed in sandy alluvium or sandy

dredge spoils. In most areas of this complex the soils have been, graded, cut, filled, or otherwise disturbed. The Pilchuck soils and Urban land are together in such an intricate pattern that to separate them in mapping was not practical.

About 15 percent of this complex are areas of Pilchuck soils that are relatively undisturbed. Typically, the surface layer is very dark grayish brown sand about 12 inches thick. The underlying material is dark grayish brown sand to a depth of 60 inches or more.

About 35 percent of this complex is sandy material 20 feet or more in depth. This material has been dredged and deposited over Moag, Rafton, and Sauvie soils, and in some areas small lakes have been filled. In most areas the fill has raised the surface to an elevation above the annual flood stage. A water table is at a depth of 2 to 4 feet from November through April.

About 35 percent of this complex is Urban land. The soils are covered by concrete, asphalt, buildings, or other impervious surfaces.

Included with this complex in mapping are areas of Moag, Rafton, Faloma, and Sauvie soils. Also included are areas of cut and fill from silty or cobbly materials. Included areas make up about 15 percent of the complex.

In areas of Pilchuck soils where vegetation has become established, black cottonwood, willow, trailing blackberry, forbs, and grasses are dominant.

In the larger areas of Pilchuck soils a limited variety of vegetation is produced. This vegetation furnishes limited food for California quail, mourning dove, and wintering waterfowl. Other common wildlife species are foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, crows, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Areas of these soils along the waterfront are commonly infested by a large population of rats. The potential for wildlife habitat is good in the larger areas of undisturbed Pilchuck soils. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitations for wildlife habitat are droughtiness and encroachment of adjacent industrial areas.

In areas of undisturbed Pilchuck soils, permeability is very rapid and available water capacity is 3 to 6 inches. The hazard of soil blowing is moderate in areas not protected by vegetative cover, and in areas of recently dredged material the hazard of soil blowing is high.

Areas of undisturbed Pilchuck soils are droughty, subject to heavy foot traffic, and shaded by tall buildings during certain times of the day. These areas of Pilchuck soils have fair potential for lawn grasses, shade trees, ornamental trees, and shrubs. The dredged materials have lower organic matter content than the Pilchuck soils. They are subject to a greater hazard of soil blowing and have less potential for lawn grasses, shade trees, ornamental trees, and shrubs. Irrigation is necessary for lawn grasses, landscaping plants, and vegetable gardens.

This complex is used for industrial development and for such recreational uses as hiking and picnicking.

This map unit is not assigned to a capability subclass.

34A-Powell silt loam, 0 to 3 percent slopes. This somewhat poorly drained soil is on broad high terraces. This soil formed in silty materials. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown, mottled silt loam about 8 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cornelius and Wollent soils, and steeper Powell soils. The included areas make up as much as 10 percent of this map unit.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 18 to 24 inches from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. The major crops are grain, berries, vegetables, nursery stock, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is most successful if done when the soil is dry than when wet. This soil has a perched water table in winter and early in spring. Tile drainage systems are difficult to install because of shallow depth of the hardpan. Tile drainage systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, western redcedar, red alder, bigleaf maple, willow, Pacif-

is dogwood, roses, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, common snowberry, forbs, and grasses.

This soil is along the fringe of the valley where areas of openland and woodland are intermingled. A wide variety of vegetables, fruits, grain, and grasses along with shrubs and trees furnish good food and cover for wildlife. Resident and seasonal wildlife on this soil are raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Birdlife includes hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, California quail, ring-necked pheasant, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitation for wildlife is the proximity of this soil to urban areas.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are a seasonal high water table, slow permeability, 20 to 30 inch depth to the fragipan, and low strength. Dwellings and roads must be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade trees and ornamental trees. Recreational uses are limited because of a seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIw.

34B-Powell silt loam, 3 to 8 percent slopes. This somewhat poorly drained soil is on broad high terraces. This soil formed in silty materials. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown, mottled silt loam about 8 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cornelius and Wollent soils and other Powell soils. The included soils make up as much as 10 percent of this map unit.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 18 to 24 inches from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If this soil is drained, most climatically adapted crops do well. The major crops are grain, berries, vegetables, nursery stock (fig. 14), hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil against erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if used when the soil is dry than when wet. This soil has a perched water table in winter and early in spring. Tile drainage systems are difficult to install because of shallow depth to the hardpan. Tile systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, western redcedar, red alder, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, roses, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, common snowberry, forbs, and grasses.

This soil is along the fringe of the valley where areas of openland and woodland are intermingled. A wide variety of vegetable, fruit, grain, and grass crops along with shrubs and trees furnish good food and cover for wildlife. Resident and seasonal wildlife species on this soil are raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Birdlife includes hawks, owls, jays, ravens, crow, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, California quail, ring-necked pheasant, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitation for wildlife is the proximity of this soil to urban areas.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are a seasonal high water table, slow permeability, 20 to 30 inch depth to the fragipan,

Figure 14.- Nursery stock on Powell silt loam, 3 to 8 percent slopes.

and low strength. Dwellings and roads can be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Recreational uses are limited by the seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

34C-Powell silt loam, 8 to 15 percent slopes. This somewhat poorly drained soil is on broad high terraces. This soil formed in silty materials. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown, mottled silt loam about 8 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cornelius and Wollent soils, and other Powell soils. The included soils make up as much as 10 percent of this map unit.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is at a depth of 18 to 24 inches from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is suited to farming. If it is drained, most climatically adapted crops do well. The major crops are grain, berries, vegetables, nursery stock, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. This soil has a perched water table in winter and early in spring. Tile drainage systems are difficult to install because of shallow depth to the hardpan and slopes of 8 to 15 percent. Tile systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, western redcedar, red alder, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, roses, salal, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, common snowberry, forbs, and grasses.

This soil is along the fringe of the valley where areas of openland and woodland are intermingled. A wide variety of grain, grass, fruit, and vegetable crops along with shrubs and trees furnish good food and cover for wildlife. Resident and seasonal wildlife species on this soil are raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Birdlife includes hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, California quail, ring-necked pheasant, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitation for wildlife is the proximity of this soil to urban areas.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are a seasonal high water table, slow permeability, low strength, 20 to 30 inch depth to the fragipan, and slopes of 8 to 15 percent. Dwellings and roads must be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation during summer is required for lawn grasses, shrubs, vines, vegetables, and most shade trees and ornamental trees. Recreational uses are limited by slope and the seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

34D-Powell silt loam, 15 to 30 percent slopes.

This somewhat poorly drained soil is on broad, high terraces. This soil formed in silty materials. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown, mottled silt loam about 8 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cornelius and Wollent soils and other Powell soils. The included soils make up as much as 15 percent of this map unit.

Permeability is slow. Effective rooting depth is 20 to 30 inches. Available water capacity is 5 to 7.5 inches. Water-supplying capacity is 17 to 19 inches. Runoff is medium, and the hazard of erosion is high. A water table is at a depth of 18 to 24 inches from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is poorly suited to farming. If it is drained, most climatically adapted crops do well. The major crops are grain, hay, and pasture. Irrigation during summer is required for maximum production of most crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Tillage and planting across slopes helps reduce runoff and erosion. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control

runoff and erosion. A cloddy condition helps protect the soil against erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up the pan and is more successful if done when the soil is dry. The soil has a perched water table in winter and early in spring. Tile drainage systems are difficult to install because of shallow depth to the hardpan. Tile systems are installed across the slope to intercept ground water. Subsoiling should be across the tile lines. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron.

The vegetation in areas not cultivated is Douglas-fir, western redcedar, red alder, bigleaf maple, willow, Pacific dogwood, wild cherry, western hazel, thimbleberry, salal, vine maple, trailing blackberry, Cascade Oregon-grape, swordfern, roses, common snowberry, forbs, and grasses.

This soil is along the fringe of the valley where areas of openland and woodland are intermingled and about equal in extent. A wide variety of grain, grasses, and fruit and vegetable crops along with shrubs and trees furnish good food and cover for wildlife. Resident and seasonal wildlife on this soil are raccoon, skunks, foxes, opossum, rabbits, squirrels, mice, moles, and gophers. Birdlife includes hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, ruffed grouse, California quail, ring-necked pheasant, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased homesite construction on this soil. The main limitations for urban development are a seasonal high water table, slow permeability, low strength, 20 to 30 inch depth to the fragipan, and slopes of 15 to 20 percent. Dwellings and roads must be designed to offset these limitations. Excavating during summer is difficult because of the strongly compacted fragipan. Slumping is possible in areas of cut and fill. Because of the slumping, additional maintenance of banks, roads, and building foundations is required. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces. Septic tank absorption fields do not function properly during rainy periods because of wetness, steep slopes, and slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Recreational uses are limited by the seasonal high water table. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IVe.

35A-Powell-Urban land complex, 0 to 3 percent slopes. This complex consists of somewhat poorly drained Powell soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on convex side slopes of broad high terraces. Areas are generally irregular in shape and 15 to 100 acres in size. The Powell soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Powell soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown, mottled silt loam about 8 inches thick. The substratum is a brown, mottled, silt loam fragipan to a depth of 60 inches of more.

About 30 percent of this complex are areas of Powell soils that have been disturbed. These soils have been covered by as much as 20 inches of fill material, or as much as 30 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Powell soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Wollent and Cornelius soils and steeper Powell soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is slow and available water capacity is 5 to 7.5 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Powell soils have a water table within a depth of 18 to 24 inches from December to April. The water table is perched on the fragipan. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are the seasonal high water table, slow permeability, and a fragipan at a depth of 20 to 30 inches. Excavating during summer is difficult because of the strongly compacted fragipan. A seasonal water table is perched on top of the fragipan and requires drainage for best results with basements and crawl spaces.

Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irriga-

tion during summer is desirable. Plants that tolerate a seasonal water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by the seasonal high water table.

This map unit is not assigned to a capability subclass.

36A-Quafeno loam, 0 to 3 percent slopes. This moderately well drained soil is on low terraces. This soil formed in loamy old alluvium. Elevation is 40 to 100 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil is dark yellowish brown loam and dark brown very fine sandy loam about 20 inches thick. It is mottled in the lower part. The substratum is brown, mottled very fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Quatama, Burlington, Latourell, and Sauvie soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 9 to 12 inches. Water-supplying capacity is 18 to 20 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are row crops, nursery crops, berries, grains, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salas, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and ruffed grouse, Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table and moderately slow permeability. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIw.

36B-Quafeno loam, 3 to 8 percent slopes. This moderately well drained soil is on low terraces. The soil formed in loamy old alluvium. Elevation is 40 to 100 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil is dark yellowish brown loam and dark brown very fine sandy loam about 20 inches thick. It is mottled in the lower part. The substratum is brown, mottled very fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Quatama, Burlington, Latourell, and Sauvie soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 9 to 12 inches. Water-supplying capacity is 18 to 20 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are row crops, nursery crops, berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and ruffed grouse. Other common wildlife species are some black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table and moderately slow permeability. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation is desirable during summer. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIe.

36C-Quafeno loam, 8 to 15 percent slopes. This moderately well drained soil is on short escarpment fronts of loamy, low terraces. This soil formed in old alluvium. Elevation is 40 to 100 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil is dark yellowish brown loam and dark brown very fine sandy loam about 20 inches thick. It is mottled in the lower part. The substratum is dark brown, mottled very fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Quatama, Burlington, Latourell, and Sauvie soils and other Quafeno soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 9 to 12 inches. Water-supplying capacity is 18 to 20 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are row crops, nursery crops, berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Deep subsoiling is required to break up

this pan and is more successful if done when the soil is dry than when wet. Tile drainage systems installed across the slope improve efficiency. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, and ruffed grouse. Other common wildlife species are some black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable .vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table, moderately slow permeability, low strength, and slopes of 8 to 15 percent. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

37A-Quatama loam, 0 to 3 percent slopes. This moderately well drained soil is on low terraces. This soil formed in old alluvium. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam about 39 inches thick, it is mottled in the lower part. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade, Aloha, Powell, Quafeno, and Latourell soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 10 inches. Water-supplying capacity is 18 to 20 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help to maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant and California quail. Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table and moderately slow permeability. Dwellings and roads can

be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty growing conditions should be selected when irrigation is not provided.

This soil is in capability subclass llw.

37B-Quatama loam, 3 to 8 percent slopes. This moderately well drained soil is on low terraces. This soil formed in old alluvium. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam about 39 inches thick. It is mottled in the lower part. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade, Aloha, Powell, Quafeno, and Latourell soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 10 inches. Water-supplying capacity is 18 to 20 inches. Runoff is slow, and the hazard of erosion is slight. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Grassed waterways help control erosion in drainageways. Limiting tillage to seedbed preparation and weed control helps control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry then when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant and California quail. Other common wildlife species are some black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table and moderately slow permeability. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation in summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIe.

37C-Quatama loam, 8 to 15 percent slopes. This moderately well drained soil is on short escarpment fronts of low terraces. This soil formed in old alluvium. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam about 39 inches thick. It is mottled in the lower part. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade, Aloha, Powell, Latourell, and Quafeno soils and other Quatama soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 10 inches. Water-supplying capacity is 18 to 20 inches. Runoff is medium, and the hazard of erosion is moderate. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Deep subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant and California quail. Other common wildlife species are some black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table, moderately slow permeability, low strength, and slopes of 8 to 15 percent. Dwellings and roads can be designed to offset the limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

37D-Quatama loam, 15 to 30 percent slopes. This moderately well drained soil is on short escarpment fronts of low terraces. This soil formed in old alluvium. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam about 39 inches thick. It is mottled in the lower part. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Cascade, Aloha, Powell, Latourell, and Quafeno soils and other Quatama soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 8 to 10 inches. Water-supplying capacity is 18 to 20 inches. Runoff is medium, and the hazard of erosion is high. A water table is at a depth of 2 to 3 feet from December through April.

This soil is used for farming, urban development, and wildlife habitat.

This soil is poorly suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are berries, grain, hay, and pasture. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Limiting slope length by stripcropping or terracing helps reduce sheet and rill erosion. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Deep subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Tile drainage systems are installed across the slope to intercept ground water. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Water needs to be applied slowly to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, potassium, sulfur, and lime and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Strawberries, alfalfa, and other crops that require good drainage can be grown if a deep, random tile system is installed.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western redcedar, bigleaf maple,

willow, western hazel, creambush oceanspray, roses, trailing blackberry, salal, tall Oregon-grape, common snowberry, Pacific dogwood, brackenfern, forbs, and grasses.

A wide variety of grasses, grain, and fruit and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant and California quail. Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, jays, crows, woodpeckers, robins, blackbirds, larks, starlings, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

Increased population growth has resulted in increased urban development on this soil. The main limitations for urban development are a seasonal high water table, moderately slow permeability, low strength, and slopes of 15 to 30 percent. Dwellings and roads can be designed to offset these limitations if sewers are provided. In places, septic tank absorption fields do not function properly during rainy periods because of wetness, steep slopes, and the moderately slow permeability. Drainage is required for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IVe.

38A-Quatama-Urban land complex, 0 to 3 percent slopes. This complex consists of moderately well drained Quatama soils. In most areas of this complex the soils have been graded, cut, filled, or otherwise disturbed. This complex is on short escarpment fronts of low terraces. Areas are generally long and narrow and 15 to 50 acres in size. The Quatama soils and Urban land are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 20 percent of this complex are areas of Quatama soils that are relatively undisturbed. Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam. It is mottled in the lower part and is about 39 inches thick. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

About 30 percent of this complex are areas of Quatama soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Quatama soils that have been cut or graded.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Included with this complex in mapping are areas of Cascade, Aloha, Powell, Quafeno, and Latourell soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderately slow and available water capacity is 8 to 10 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. The areas of Quatama soils that are undisturbed have a water table within a depth of 3 feet during December to April. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are moderately slow permeability and a seasonal high water table. Large areas of this map unit are drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Irrigation during summer is desirable for most lawn grasses, shrubs, vines, vegetables, shade trees, and ornamental trees. Plants that tolerate a seasonal water table and droughty conditions should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

39-Rafton silt loam. This very poorly drained soil is on broad flood plains of the Columbia River. This soil formed in recent alluvium with some mixing of volcanic ash. Elevation is 10 to 20 feet. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown, mottled silt loam about 9 inches thick. The subsoil is grayish brown, brown, and gray, mottled silt loam about 31 inches thick. The substratum is dark grayish brown, mottled silt loam over very dark gray silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Moag, Pilchuck, and Sauvie soils. The included soils make up as much as 10 percent of this unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is very slow. The hazard of erosion from overflow is high. The soil is subject to frequent flooding from December to June. A water table is within a depth of 12 inches from December through July.

This soil is used for farming and wildlife habitat.

This soil is very poorly suited to farming. Only plants that can withstand prolonged inundation by flooding and long periods of a high water table are adapted. Grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime. Irrigation during summer is required for maximum crop production.

The native vegetation is black cottonwood, willow, roses, common snowberry, sedges, cattails, and grasses.

A wide variety of vegetation grows on this soil and furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, mourning dove, and wintering waterfowl. Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to large bodies of water, it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

This soil is severely limited for homesites and other urban uses. The main limitations for urban development are frequent flooding and a seasonal high water table.

This soil is in capability subclass Vlw.

40-Rafton silt loam, protected. This very poorly drained soil is on broad flood plains of the Columbia River. It formed in recent alluvium with some mixing of volcanic ash. Elevation is 10 to 20 feet. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown, mottled silt loam about 9 inches thick. The subsoil is grayish brown, brown, and gray, mottled silt loam about 31 inches thick. The substratum is dark grayish brown, mottled silt loam over very dark gray silt loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Moag, Pilchuck, and Sauvie soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is very slow, and the hazard of erosion is slight. The soils are protected from flooding by dikes and levees but are subject to frequent ponding from December to April. A water table is from 2 feet above the surface to 12 inches below the surface from December through April.

This soil is used for farming and wildlife habitat.

This soil is well suited to farming. Large areas have been drained and are farmed. If this soil is drained and crops are protected from ponding, most climatically adapted crops do well. Perennial crops that withstand ponding during winter are adapted. The major crops are sweet corn, row crops, and spring barley. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used. Irrigation helps increase crop production during dry periods in summer. Grain and grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime.

The vegetation in areas not cultivated is black cottonwood, willow, roses, common snowberry, sedges, cattails, and grasses.

A wide variety of grain, grasses, and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, and mourning dove. Ponded areas are excellent for waterfowl in winter. Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to large bodies of water, it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat. Numerous undrained areas of this soil provide small ponds, which can be managed for waterfowl.

This soil is severely limited for homesites and other urban uses. The main limitations for urban development are frequent ponding and very poor drainage.

This soil is in capability subclass 1llw.

41-Riverwash. These miscellaneous areas are narrow, irregular strips in the bends of stream channels along the Columbia, Willamette, and Sandy Rivers and along most drainageways in the survey area. Areas are 2 to 10 feet above the common water level of the stream. Slopes are 0 to 3 percent. The average annual precipitation is 40 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 140 to 200 days.

Riverwash is used for recreation, a source of gravel, and wildlife habitat.

Riverwash is variable, but generally consists of well rounded sand, gravel, cobbles, stones, and boulders derived from basalt or andesite.

Included with this miscellaneous area in mapping are areas of Dabney and Pilchuck soils. The included soils make up as much as 10 percent of this map unit.

Permeability is very rapid. Effective rooting depth is 60 inches or more. Available water capacity and water-supplying capacity are variable. Runoff is slow, but the hazard of erosion is high. Riverwash is subject to overflow when the water is high and is extremely droughty when the water is low. During each new overflow, new deposits are received or material is removed.

The vegetation is occasional bunches of grass and scattered shrubs, such as willows.

This map unit is popular for such recreational activities as picnicking, hiking, camping and fishing.

The sparse vegetation on Riverwash furnishes little food and cover for wildlife. At times, the gravel bars are important spawning grounds for anadromous fish. Other wildlife species occasionally on or near Riverwash are black-tailed deer, raccoon, skunks, opossum, and beaver. Birdlife includes hawks, owls, herons, jays, crows, woodpeckers, flycatchers, water ouzel, and many kinds of small birds. Wintering waterfowl are in some areas.

Riverwash is severely limited for homesites and other urban uses by frequent flooding.

This map unit is in capability subclass VIIIw.

42F-Rock outcrop-Rubble land complex, very steep. This complex consists of intermingled areas of Rock outcrop and Rubble land. It is about 55 to 65 percent Rock outcrop and 30 to 40 percent Rubble land (fig. 15). This complex is on uplands in deposits of basalt and andesite outcrop and rubble. Almost perpendicular cliffs as much as 500 feet high are in areas of this complex, mainly along the Columbia River. Slopes are 30 to 100 percent. Rock outcrop-Rubble land complex has little or no vegetation except on included soils. Elevation is 100 to 4,200 feet. The average annual precipitation is 70 to 135 inches, the average annual air temperature is 40 to 54 degrees F, and the frost-free period is 10 to 200 days.

Included with this complex in mapping are areas of Aschoff, Kinzel, Divers, Lastance, Talapus, and Wahkeena soils. The included soils make up as much as 20 percent of this map unit.

This complex has poor potential for most uses. It is limited by very steep rocky slopes and cliffs that have rocky foot slopes. The sparse vegetation furnishes little food and cover for wildlife. These rocky areas are important as habitat for coney. Other wildlife species that are

Figure 15.- Rock outcrop-Rubble land complex, very steep, on canyon side slopes. Talapus soils are on the ridgetops.

occasionally on or near this map unit are black bear, coyote, bobcat, cougar, skunks, weasels, marten, raccoon, mink, rabbits, and squirrels. Birdlife includes hawks, eagles, owls, jays, and many kinds of small birds. This complex has good potential for use as natural areas; as habitat for some kinds of wildlife, and as a source of rock. It also has good potential for water supply.

This map unit is in capability subclass VIIIs.

43C-Saum silt loam, 8 to 15 percent slopes. This well drained soil in on smooth low hills. This soil formed in mixed silty alluvium, slope wash, and residuum from basalt. Slopes are convex. Elevation is 250 to 900 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark reddish brown silt loam about 11 inches thick. The subsoil is dark reddish brown silty clay loam about 25 inches thick. The substratum is reddish brown very gravelly silty clay loam about 14 inches thick.

Included with this soil in mapping are areas of Cascade, Cornelius, and Helvetia soils and other Saum soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 40 to 60 inches. Available water capacity is 6 to 8 inches. Water-supplying capacity is 20 to 22 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for farming, urban development, timber production, and wildlife habitat.

This soil is suited to farming. The main limitations are effective rooting depth, slopes of 8 to 15 percent, and 6 to 8 inches of available water capacity. Returning all crop residue to the soil and including grasses, legumes, or grass-legumes mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Cross-slope farming, grassed waterways, and limiting tillage to seedbed preparation and weed control help control runoff and erosion. A cloddy condition helps protect the soil from erosion during rainy periods.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Sprinkler irrigation can be used to increase crop production in periods in summer. Water needs to be applied slowly to prevent runoff. Grasses respond to nitrogen. Berries respond to nitrogen, phosphorus, potassium, and sulfur and in places, to boron. Legumes need applications of phosphorus, sulfur, boron, and lime.

The vegetation in areas not cultivated is Douglas-fir, Oregon white oak, western hazel, poison oak, creambush oceanspray, tall Oregon-grape, common snowberry, roses, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 130 to 140. Based on a site index of 136, this soil is capable of producing about 9,125 cubic feet from a fully stocked stand of 70-year old trees, or 47,400 board feet (international rule one-fourth inch kerf) of merchantable timber from a fully stocked, even-aged stand of 80-year old trees. Brushy species, including western hazel, poison oak, common snowberry, roses, and Oregon white oak, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the long, dry summer and the resultant droughty condition that limits establishment of young trees. If the soil is wet, the use of some conventional logging methods is limited in areas. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a base of rock.

A wide variety of grasses, shrubs, and trees grow on this soil. This variety of plants furnishes food and cover for ring-necked pheasant, California quail, bobwhite quail, and ruffed grouse. Other common wildlife species are black-tailed deer, gophers, squirrels, raccoon, opossum, skunks, and rabbits. Birdlife includes hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

This soil has moderate limitation for homesites because of low strength, moderately slow permeability, and slopes of 8 to 15 percent. Dwellings with basements have moderate limitation because of the depth to hard basalt bedrock. Dwellings and roads can be designed to offset these limitations if sewers are provided. Septic tank absorption fields do not function properly in places because of the moderately slow permeability and slopes of 8 to 15 percent. Irrigation during summer is desirable for most lawn grasses, shrubs, vines, vegetables, shade trees, and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIe.

43E-Saum silt loam, 30 to 60 percent slopes. This well drained soil is on side slopes of low hills. This soil formed in mixed silty alluvium, slope wash, and residuum weathered from basalt. Elevation is 250 to 900 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark reddish brown silt loam about 11 inches thick. The subsoil is dark reddish brown silty clay loam about 25 inches thick. The substratum is reddish brown very gravelly silty clay loam about 14 inches thick.

Included with this soil in mapping are areas of Cascade, Cornelius, and Helvetia soils and more steeply sloping Saum soils. The included soils make up as much as 15 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 40 to 60 inches. Available water capacity is 6 to 8 inches. Water-supplying capacity is 20 to 22 inches. Runoff is rapid, and the hazard of erosion is high.

This soil is used for timber production, urban development, and wildlife habitat.

Vegetation is Douglas-fir, Oregon white oak, western hazel, poison oak, creambush oceanspray, tall Oregon-grape, common snowberry, roses, forbs, and grasses.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 130 to 140. Based on a site index of 136, this soil is capable of producing about 9,125 cubic feet from a fully stocked stand of 70-year old trees, or 47,400 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including western hazel, poison oak, common snowberry, roses, and Oregon white oak, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the long, dry summer and the resultant droughty condition that limits establishment of young trees. Because of steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvesting. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. All-season roads on this soil need a base of rock.

A wide variety of grasses, shrubs, and trees grow on this soil. The variety of plants furnishes food and cover for ring-necked pheasant, California quail, bobwhite quail, and ruffed grouse. Other common wildlife species are black-tailed deer, gophers, squirrels, raccoon, opossum, skunks, and rabbits. Birdlife includes hawks, owls, jays, ravens, crows, vultures, woodpeckers, insect eaters, mourning dove, band-tailed pigeon, and many kinds of small birds. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

This soil has severe limitation for homesites because of slopes of 30 to 60 percent. Other limitations include bedrock at a depth of 40 to 60 inches, low strength, and moderately slow permeability. Dwellings and roads can be designed to offset these limitations if sewers are provided. Septic tank absorption fields do not function properly in places because of steep slopes and moderately slow permeability. Irrigation during summer is desirable for most lawn grasses, shrubs, vines, vegetables, shade trees, and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided. In places, cut areas require mulching and fertilizing to establish plants.

This soil is in capability subclass Vle.

44-Sauvie slit loam. This poorly drained soil is on broad flood plains of the Columbia River. This soil formed in recent alluvium with some mixing of volcanic ash. Elevation is 10 to 20 feet. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is mainly dark grayish brown silty clay loam. The subsoil is mottled and is about 24 inches thick. The substratum is dark grayish brown, mottled very fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie silty clay loam and areas of Moag, Pilchuck, and Rafton soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is slow, and the hazard of erosion from overflow is high. This soil is subject to frequent flooding from December to June. A water table is within a depth of 12 inches during May and June.

This soil is used for farming and wildlife habitat.

This soil is very poorly suited to farming. Adapted plants are those that can withstand prolonged inundation by flooding and the presence of a high water table for long periods. Disturbed areas require protection from washing during winter. Grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime. Irrigation during dry periods in summer is required for maximum crop production.

The native vegetation is Oregon white oak, Oregon ash, black cottonwood, willow, roses, common snowberry, trailing blackberry, forbs, and grasses.

A wide variety of vegetation grows on this soil and furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, mourning dove, and wintering waterfowl. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to large bodies of water, it provides food and habitat for beaver, muskrat, nutria, mink, and otter. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

This soil is severely limited for homesites and other urban uses. The main limitations for urban development are frequent flooding and a seasonal high water table. Recreational uses are limited by seasonal flooding.

This soil is in capability subclass Vlw.

45-Sauvie silt loam, protected. This poorly drained soil is on broad flood plains of the Columbia River. This soil formed in recent alluvium with some mixing of volcanic ash (fig. 16). Elevation is 10 to 20 feet. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

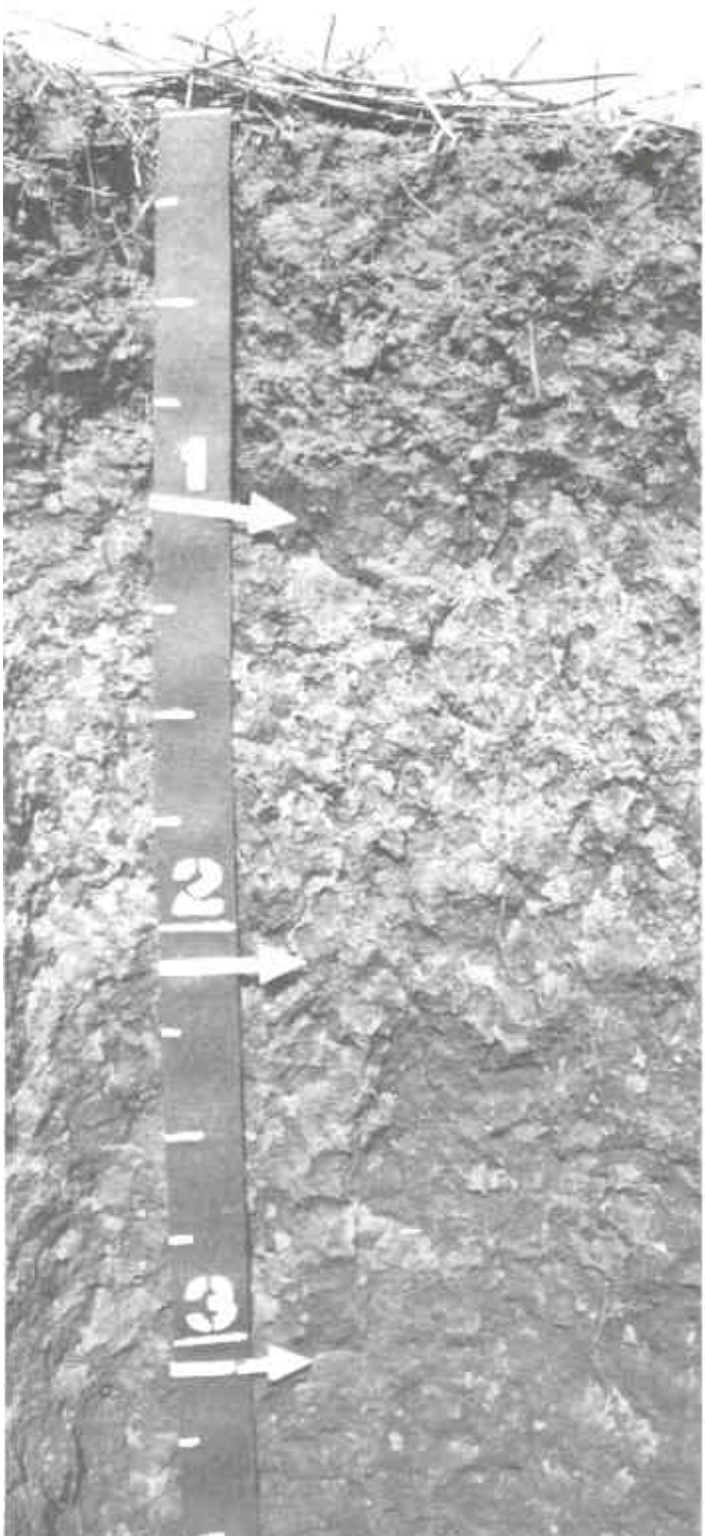

Figure 16.- Profile of Sauvie silt loam, protected.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is mainly dark grayish brown silty clay loam. The subsoil is mottled and about 24 inches thick. The substratum is dark grayish brown, mottled very fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie silty clay loam and areas of Moag and Rafton soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is slow, and the hazard of erosion is slight. This soil is protected from flooding by dikes and levees.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. Large areas have been drained and are farmed. If this soil is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are sweet corn, row crops, nursery crops, and grain crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in the fall. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used. Irrigation water needs to be applied carefully at rates low enough to prevent runoff. Grain and grass crops respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime. Vegetables and berries respond to nitrogen, phosphorus, and potassium.

The vegetation in areas not cultivated is Oregon white oak, Oregon ash, black cottonwood, willow, roses, common snowberry, trailing blackberry, forbs, and grasses.

A wide variety of grain, grasses, and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many other kinds of small birds. Where this soil is adjacent to bodies of water, it provides food and habitat for numerous waterfowl. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat (fig. 17).

This soil is limited for homesites and other urban uses. The main limitation for urban development is moderate shrink-swell potential. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables and most shade trees and ornamental trees.

This soil is in capability subclass IIw.

Figure 17.- Wildlife plantings provide food and cover for geese and ducks on Sauvie silt loam, protected.

46-Sauvie silty clay loam, protected. This poorly drained soil is on broad flood plains of the Columbia River. This soil formed in recent alluvium with some mixing of volcanic ash. Elevation is 10 to 20 feet. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silty clay loam about 15 inches thick. The subsoil is very dark grayish brown silty clay loam over dark grayish brown silty clay loam. The subsoil is mottled and is about 24 inches thick. The substratum is dark grayish brown, mottled very fine sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie silt loam and areas of Moag, Pilchuck, and Rafton soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is slow, and the hazard of erosion is slight. This soil is protected from flooding by dikes and levees.

This soil is used for farming, urban development, and wildlife habitat.

This soil is well suited to farming. Large areas have been drained and are farmed. If this soil is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. The major crops are sweet corn, row crops, nursery crops, and grain crops. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used. Irrigation water needs to be applied carefully at rates low enough to prevent runoff. Grain and grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime. Vegetables and berries respond to nitrogen, phosphorus, and potassium.

The vegetation in areas not cultivated is Oregon white oak, Oregon ash, black cottonwood, willow, roses, common snowberry, trailing blackberry, forbs, and grasses.

A wide variety of grain, grasses, and vegetable crops along with shrubs and trees grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant, California quail, bobwhite quail, and mourning dove. Other common wildlife species are a few black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, and mice. Birdlife includes hawks, owls, vultures, jays, crows, woodpeckers, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Where this soil is adjacent to bodies of water, it provides food and habitat for numerous waterfowl. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

This soil is limited for homesites and other urban uses. The main limitation for urban development is moderate shrink-swell potential. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade trees and ornamental trees.

This soil is in capability subclass IIw.

47A-Sauvie-Rafton-Urban land complex, 0 to 3 percent slopes. This complex consists of very deep, poorly drained Sauvie soils and very poorly drained Rafton soils. Large areas of these soils have been filled, graded, cut, or otherwise disturbed. This complex is on broad flood plains along the Columbia River. Areas are generally long and narrow and are 40 to 100 acres in size. The Sauvie and Rafton soils and Urban land are in such an intricate pattern that to separate them in mapping was not practical. Elevation is 10 to 20 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 25 percent of this complex are areas of Sauvie soils that are relatively undisturbed. Typically, the surface

layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is mainly dark grayish brown silty clay loam. The subsoil is mottled and is about 24 inches thick. The substratum is dark grayish brown, mottled very fine sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Rafton soils that are relatively undisturbed. Typically, the surface layer is dark grayish brown, mottled silt loam about 9 inches thick. The subsoil is grayish brown and brown, mottled silt loam about 31 inches thick. The substratum is dark grayish brown silt loam over black silt loam to a depth of 60 inches or more.

About 15 percent of this complex are areas of Sauvie and Rafton soils that have been disturbed. These soils have been covered by as much as 10 feet of fill material. The fill material is generally transported and consists of soil material, as well as concrete, asphalt, and other impervious materials.

About 25 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

Permeability is moderately slow in the Sauvie soil. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is slow, and the hazard of erosion is slight. A water table is within a depth of 12 inches from December through July.

Permeability is moderate in the Rafton soil. Effective rooting depth is 60 inches or more. Available water capacity is 11 to 13 inches. Water-supplying capacity is 21 to 25 inches. Runoff is very slow. A water table is within a depth of 12 inches from December through July.

Included with this complex in mapping are areas of Moag and Pilchuck soils. The included soils make up about 10 percent of this complex.

This map unit is used for urban development, recreation, and wildlife habitat.

In areas of undisturbed Sauvie soils, the vegetation is Oregon white oak, Oregon ash, black cottonwood, willow, roses, common snowberry, trailing blackberry, forbs, and grasses.

In areas of undisturbed Rafton soils, the vegetation is black cottonwood, willow, roses, common snowberry, sedges, cattails, and grasses.

In the larger areas of undisturbed Sauvie and Rafton soils, a limited variety of vegetation is produced. This vegetation furnishes limited food for California quail, mourning dove, and waterfowl. Other common wildlife species are foxes, skunks, raccoon, opossum, rabbits, rats, and mice. Birdlife includes hawks, owls, crows, flycatchers, shore birds, blackbirds, larks, starlings, and many kinds of small birds. Areas along the waterfront are commonly infested with a large population of rats. the potential for wildlife habitat is good in the larger areas of undisturbed Sauvie and Rafton soils. Planting desirable vegetation and protecting existing vegetation improve the habitat. The main limitations for wildlife habitat are the close proximity and resulting conflict with adjacent industrial areas.

The main limitations of these soils for urban development are the seasonal high water table and moderately slow permeability. Septic tank absorption fields do not function properly in places during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by a seasonal high water table.

This complex is not assigned to a capability subclass.

48-Sifton gravelly loam, occasionally flooded.

This somewhat excessively drained soil is on low terraces along the Columbia River. This soil formed in gravelly alluvium. Elevation is 15 to 25 feet. Slope is 0 to 3 percent. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 170 to 210 days.

Typically, the surface layer is black and very dark brown gravelly loam about 21 inches thick. The subsoil is very dark brown gravelly sandy loam about 9 inches thick. The substratum is dark brown very gravelly loamy coarse sand to a depth of 60 inches or more.

Included with this soil in mapping are areas of Sauvie, Moag, Pilchuck, and Rafton soils. The included soils make up as much as 10 percent of this map unit.

Permeability is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is 3 to 5 inches. Water-supplying capacity is 15 to 18 inches. Runoff is slow. The hazard of erosion from overflow is high. This soil is subject to occasional flooding from December to June.

This soil is used for farming and wildlife habitat.

This soil is suited to farming. The major crops grown are hay, pasture, and small grain. In places, the high content of coarse fragments in the surface layer is a concern to tillage. Available water capacity is low. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall. Returning crop residue to the soil helps maintain fertility and tilth. Where grain crops are grown, fertility can be maintained by use of cover crops, green-manure crops, and a cropping system that includes soil-building crops. Sprinkler irrigation can be used to increase crop production in dry periods in summer. Grain and grass crops need nitrogen. Legumes respond to phosphorus, boron, and sulfur.

The vegetation in areas not cultivated is Oregon white oak, Oregon ash, willow, black cottonwood, roses, common snowberry, trailing blackberry, forbs, and grasses (fig. 18).

A wide variety of grain and grasses along with trees and shrubs grow on this soil. This variety of plants furnishes good food and cover for ring-necked pheasant,

Figure 18.- Oregon white oak, roses, common snowberry, forbs, and grasses on Sifton gravelly loam, occasionally flooded.

mourning dove, and California quail. Other common wildlife species are black-tailed deer, foxes, skunks, raccoon, opossum, rabbits, squirrels, and mice. Birdlife includes hawks, owls, vultures, herons, eagles, jays, crows, woodpeckers, flycatchers, hummingbirds, shore birds, blackbirds, and many kinds of small birds. Where this soil is adjacent to bodies of water, it provides excellent food and habitat for ducks (fig. 19), geese, swans, and other types of migratory waterfowl. The potential for wildlife habitat is good. Planting desirable vegetation and protecting existing vegetation improve the habitat.

This soil is poorly suited to urban uses. The main limitations for urban use are flooding, the gravelly surface layer, and very rapid permeability of the underlying gravel. Septic tank absorption fields contaminate adjacent water sources in places because of the very rapid permeability and occasional flooding. Irrigation during summer is desirable for lawn grasses, shrubs, vines, shade trees, and ornamental trees. To establish plants in disturbed areas is difficult. Mulching, fertilizing, and irrigation help establish plants. For best results in landscaping, particularly in disturbed areas that are utilized for lawns, removal of pebbles and cobbles is required. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass IIIw.

49D-Talapus-Lastance association, moderately steep. These well drained soils are on broad ridgetops on the Cascade Mountains. They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Elevation is 3,300 to 4,000 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the frost-free period is less than 30 days.

About 60 percent of this association is Talapus soils. Typically, the Talapus soil has a surface layer about 13 inches thick. It is black very gravelly silt loam over very dark brown very gravelly silt loam. The subsoil is brown extremely gravelly loam about 19 inches thick. The substratum is dark reddish brown extremely gravelly loam to a depth of 60 inches or more.

About 20 percent of this association is Lastance soils. Typically, the Lastance soil has a surface layer of gray stony fine sandy loam about 1 inch thick. The subsoil is dusky red over dark brown gravelly fine sandy loam and very cobbly fine sandy loam about 11 inches thick. The substratum is brown extremely gravelly fine sandy loam to a depth of 60 inches or more.

Included with these soils in mapping are areas of Lastance, Divers, and Kinzel soils and other Talapus soils and Rubble land. Also included are soils that are similar to the major soils but are 20 to 40 inches deep to cemented glacial till or bedrock. These inclusions make up as much as 20 percent of this map unit.

Figure 19.- Nesting boxes for wood ducks in Oregon white oak trees on Sifton gravelly loam on Sauvie Island.

Permeability is moderate in the Talapus soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is medium, and the hazard of erosion is moderate.

Permeability is moderately rapid in the Lastance soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is medium, and the hazard of erosion is moderate.

These soils are mainly used for timber, wildlife habitat, and water supply.

The vegetation in areas of these soils is western hemlock, noble fir, Douglas-fir, blue huckleberry, rhododendron, beargrass, and forbs.

The Talapus soil is suited to noble fir and western hemlock. The site index for noble fir on this soil ranges from 80 to 90. Based on a site index of 82, this soil is capable of producing about 3,840 cubic feet from a fully stocked stand of 70-year old trees, or 15,840 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 100-year old trees.

The main limitations to the Talapus soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. During periods of heavy snow pack and if the soil is wet, the use of some conventional logging methods is limited. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

The Lastance soil is suited to noble fir and western hemlock. The site index for noble fir on this soil ranges from 50 to 70. Based on a site index of 52 this soil is capable of producing about 3,700 cubic feet from a fully stocked stand of 70-year old trees, or 14,300 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 100-year old trees.

The main limitations to the Lastance soil for timber production are the cold soil temperatures, acid soil conditions, and high content of coarse fragments. During periods of heavy snow pack and if the soil is wet, the use of some conventional logging methods is limited. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas at high elevations on western slopes of the Cascade Mountains, a limited variety of trees, shrubs, grasses, and forbs grow on these soils. Vegetational stages change dramatically as a result of clear-cut logging and fires. Because of the cold soil temperatures, plant recovery and growth are slower than at a lower elevation.

The potential for wildlife, especially black-tailed deer, depends on openings in the canopy created by clearcutting and on the availability of new vegetation. Other species of wildlife are black bear, cougar, bobcat, coyotes, marten, coney, rabbits, squirrels, and chipmunks. Birds include blue grouse, ravens, hawks, owls, Clark's nutcracker, jays, wrens, and other small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities. The ecosystem is fragile, and recovery from drastic changes is very slow.

These soils have moderate limitations for urban development. The main limitation for urban development is the high concentration of coarse fragments. Climatic conditions are severe during winter. Plants adapted to a long, cold winter and a short, cool summer should be used for landscaping in developed areas and for erosion control in cut and fill areas. Mulching and fertilizing help establish plants in disturbed areas.

This association is in capability subclass VIIs.

49E-Talapus-Lastance association, steep. These well drained soils are on side slopes of canyons of the Cascade Mountains. They formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Elevation is 3,300 to 4,000 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the frost-free period is less than 30 days.

About 60 percent of this association is Talapus soils. Typically, the Talapus soil has a surface layer about 13 inches thick. It is black very gravelly silt loam over very dark brown very gravelly silt loam. The subsoil is brown extremely gravelly loam about 19 inches thick. The substratum is dark reddish brown extremely gravelly loam to a depth of 60 inches or more.

About 20 percent of this association is Lastance soils. Typically, the Lastance soil has a surface layer of gray stony fine sandy loam about 1 inch thick. The subsoil is dusky red over dark brown gravelly fine sandy loam and very cobbly fine sandy loam about 11 inches thick. The substratum is brown extremely gravelly fine sandy loam to a depth of 60 inches or more.

Included with these soils in mapping are areas of Lastance, Divers, and Kinzel soils and other Talapus soils and Rubble land. Also included are soils that are similar to the major soils but are 20 to 40 inches deep to cemented glacial till. These inclusions make up as much as 20 percent of this map unit.

Permeability is moderate in the Talapus soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is rapid, and the hazard of erosion is high.

Permeability is moderately rapid in the Lastance soil. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 25 inches. Runoff is rapid, and the hazard of erosion is high.

These soils are mainly used for timber, wildlife habitat, and water supply.

The vegetation in areas of these soils is western hemlock, noble fir, Douglas-fir, blue huckleberry, rhododendron, beargrass, and forbs.

The Talapus soil is suited to noble fir and western hemlock. The site index for noble fir on this soil ranges

from 80 to 90. Based on a site index of 82, this soil is capable of producing about 3,840 cubic feet from a fully stocked stand of 70-year old trees, or 15,840 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 100-year old trees.

The main limitations to the Talapus soil for timber production are the cold soil temperatures, steep slopes, acid soil condition, and high content of coarse fragments. Because of the steep slopes, such methods of logging as aerial, high-lead, or skyline should be used for tree harvesting. During periods of heavy snow pack and when soils are wet, logging is restricted. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

The Lastance soil is suited to noble fir and western hemlock. The site index for noble fir on this soil ranges from 50 to 70. Based on a site index of 52, this soil is capable of producing about 3,700 cubic feet from a fully stocked stand of 70-year old trees, or 14,300 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 100-year old trees.

The main limitations to the Lastance soil for timber production are the cold soil temperatures, steep slopes, acid soil condition, and high content of coarse fragments. Because of the steep slopes, methods of logging as aerial, high-lead, or skyline should be used for tree harvesting. During periods of heavy snow pack and when soils are wet, logging is restricted. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas at high elevations on western slopes of the Cascade Mountains, a limited variety of trees, shrubs, grasses, and forbs grow on these soils. Vegetational stages change dramatically as a result of clear-cut logging and fires. Because of the cold soil temperatures, plant recovery and growth are slower than at a lower elevation.

The potential for wildlife, especially black-tailed deer, depends on openings in the canopy created by clearcutting and on the availability of new vegetation. Other species of wildlife are black bear, cougar, bobcat, coyote, marten, coney, rabbits, squirrels, and chipmunks. Birds include blue grouse, ravens, hawks, owls, Clark's nutcracker, jays, wrens, and other small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities. The ecosystem is fragile, and recovery from drastic changes is very slow.

These soils have severe limitations for urban development. The main limitations for urban development are steep slopes and the high concentration of coarse fragments. Climatic conditions are severe during winter. Plants adapted to a long, cold winter and a short, cool summer should be used for landscaping in developed areas and for erosion control in cut and fill areas. Mulching and fertilizing help establish plants in disturbed areas.

This association is in capability subclass VIIs.

50A-Urban land, 0 to 3 percent slopes. This miscellaneous area is throughout the central part of Multnomah County, but is mainly in the city of Portland along the flood plains of the Willamette River. Areas of this map unit are on the Ingram geomorphic surface as described in the section, "Geomorphic surfaces and soil development." They are subject to flooding (fig. 20). The degree of flooding depends on the flood structures present and on the magnitude of the flooding. Elevation is 20 to 30 feet.

Areas of this map unit are used mainly for commercial purposes. Ninety five percent or more of the soils are covered with buildings, streets, sidewalks, parking lots, railroads, and other works and structures.

Some areas are not covered by works and structures, but most of these areas have been so altered during construction that to separate them in mapping was not practical. The original soils were gravelly loam, silt loam, or silty clay loam with some sandy materials. Cuts and fills and grading and compaction by machinery during construction have severely altered the characteristics of the original soils.

This map unit is not assigned to a capability subclass.

50C-Urban land, 3 to 15 percent slopes. This miscellaneous area is in the central part of Multnomah County, mainly in the city of Portland on first terraces above the flood plains. Areas of this map unit are on the Winkle and Champoeg geomorphic surfaces as de-

Figure 20.- Level of water during floods in 1894 and 1948 on Urban land, 0 to 3 percent slopes.

scribed in the section, "Geomorphic surfaces and soil development." Elevation is 50 to 100 feet.

Areas of this map unit are used mainly for commercial purposes. Eighty five percent or more of the soils are covered with office buildings, service buildings, hotels and motels, industrial buildings and yards, streets and sidewalks, parking lots, railroads, shopping centers, closely spaced residences, and other works and structures.

Some areas are not covered by works and structures, but most of these have been so altered during construction that to separate them in mapping was not practical. The original soils were silt loam, loam, silty clay loam, and gravelly loam and were commonly over stratified sand and gravel at a depth of 4 to 6 feet.

Included in mapping are as much as 10 percent areas that have 50 to 85 percent of the surface covered by works and structures. Also included are areas in which only a thin layer of fill material has been introduced and the buried, original soil can be identified.

This map unit is not assigned to a capability subclass.

51A-Urban land-Latourell complex, 0 to 3 percent slopes. This complex consists of Urban land and well drained Latourell soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad terraces that have long, convex slopes. Areas are generally irregular in shape and 20 to 100 acres in size. The Urban land and Latourell soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Latourell soils that are relatively undisturbed. Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Latourell soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah, Powell, and Burlington soils and more steeply sloping Latourell soils. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 8 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban uses. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

51B-Urban land-Latourell complex, 3 to 8 percent slopes. This complex consists of Urban land and well drained Latourell soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad terraces that have long, convex slopes. Areas are generally irregular in shape and 20 to 100 acres in size. The Urban land and Latourell soils are in such an intricate pattern or are so small in area that to separate them in mapping was not practical. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Latourell soils that are relatively undisturbed. Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

About 25 percent of the complex are areas of Latourell soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah, Powell, and Burlington soils and more steeply sloping Latourell soils. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 8 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for most urban uses. Slopes of 3 to 8 percent can restrict some uses. Irriga-

tion during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

51C-Urban land-Latourell complex, 8 to 15 percent slopes. This complex consists of Urban land and well drained Latourell soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad terraces that have long, convex slopes. Areas are generally irregular in shape and 20 to 100 acres in size. The Urban land and Latourell soils are in such an intricate pattern or are so small in area that to separate them in mapping was not practical. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Latourell soils that are relatively undisturbed. Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Latourell soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah, Powell, and Burlington soils and other Latourell soils. The included soils make up as much as 20 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 8 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Runoff is medium, and the hazard of erosion is moderate.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban uses. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables, and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

51D-Urban land-Latourell complex, 15 to 30 percent slopes. This complex consists of Urban land and well drained Latourell soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad terraces that have long, convex slopes. Areas are generally irregular in shape and 20 to 100 acres in size. The Urban land and Latourell soils are in such an intricate pattern or are so small in area that to separate them in mapping was not practical. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 40 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Latourell soils that are relatively undisturbed. Typically, the surface layer is dark brown and brown loam about 16 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum is dark yellowish brown loam and very gravelly sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Latourell soils that have been disturbed. These soils have been covered by as much as 40 inches of fill material, or as much as 60 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah, Powell, and Burlington soils and more steeply sloping Latourell soils. The included soils make up as much as 20 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 8 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Runoff is medium, and the hazard of erosion is high.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitation for urban development is slopes of 15 to 30 percent slopes. Slumping is possible in areas of cut and fill, and additional maintenance of banks, roads, and building foundations is required. To establish plants in areas in which the surface layer has been removed and the subsoil exposed is difficult. Mulching and fertilizing cut areas help establish plants. Irrigation during summer is desirable for lawn grasses, shrubs, vines, vegetables and most shade and ornamental trees. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

52A-Urban land-Multnomah complex, 0 to 3 percent slopes. This complex consists of Urban land and well drained Multnomah soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise

disturbed. This complex is on broad convex terraces. Areas are generally irregular in shape and 25 to 100 acres in size. The Urban land and Multnomah soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Multnomah soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The substratum is dark yellowish brown gravelly silt loam in the upper 14 inches, and below this it is very gravelly sand to a depth of 60 inches or more.

About 25 percent of this complex are areas of Multnomah soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Multnomah and Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and more steeply sloping Multnomah silt loams. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 4 to 6 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. The lower part of the substratum in undisturbed areas in places ranges from very gravelly to extremely gravelly sand and has very rapid permeability and very low water-holding capacity. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban development. In places, septic tank absorption fields contaminate ground water sources because of very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Landscaping requires removal of pebbles and cobbles in disturbed areas in places. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

52B-Urban land-Multnomah complex, 3 to 8 percent slopes. This complex consists of Urban land and well drained Multnomah soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad convex terraces. Areas are generally irregular in shape and 25 to 100 acres in size. The Urban land and Multnomah soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Multnomah soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The substratum is dark yellowish brown gravelly silt loam in the upper 14 inches and very gravelly sand to a depth of 60 inches or more.

About 25 percent of this complex are areas of Multnomah soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 50 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Multnomah and Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah gravelly silt loam and areas of Latourell, Powell, and Multnomah silt loam, 0 to 3 percent slopes. The included soils make up as much as 10 percent of this unit.

In areas where the soils are relatively undisturbed, permeability is moderate, and available water capacity is 4 to 6 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. In places, the lower part of the substratum in undisturbed areas ranges from very gravelly to extremely gravelly sand and has very rapid permeability and very low water-holding capacity. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban development. Some uses are restricted in places by slopes of 3 to 8 percent. In places, septic tank absorption fields contaminate ground water sources because of very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Landscaping requires removal of pebbles and cobbles in disturbed areas in places. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

52C-Urban land-Multnomah complex, 8 to 15 percent slopes. This complex consists of Urban land and

well drained Multnomah soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on broad convex terraces. Areas are generally irregular in shape and 25 to 100 acres in size. The Urban land and Multnomah soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Multnomah soils that are relatively undisturbed. Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 17 inches thick. The substratum is dark yellowish brown gravelly silt loam in the upper 14 inches and very gravelly sand to a depth of 60 inches or more.

About 25 percent of this complex are areas of Multnomah soils that have been disturbed. These soils have been covered by as much as 40 inches of fill material, or as much as 60 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Multnomah and Latourell soils that have been cut or graded.

Included with this complex in mapping are areas of Multnomah gravelly silt loam, Latourell and Powell soils, and other Multnomah soils. The included soils make up as much as 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderate and available water capacity is 4 to 6 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. In places, the lower part of the substratum in undisturbed areas ranges from very gravelly to extremely gravelly sand and has very rapid permeability and very low water-holding capacity. Runoff is medium, and the hazard of erosion is moderate.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. There are no major limitations for urban development. Some uses are restricted in places by slopes of 8 to 15 percent. In places, septic tank absorption fields contaminate ground water sources because of very rapid permeability in the underlying gravel. Irrigation during summer is desirable for best results with lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables. Landscaping requires removal of pebbles and cobbles in disturbed areas in places. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This map unit is not assigned to a capability subclass.

53A-Urban land-Quafeno complex, 0 to 3 percent slopes. This complex consists of Urban land and moderately well drained Quafeno soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on low terraces. Areas are generally long and narrow and are 25 to 100 acres in size. The Urban land and Quafeno soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 40 to 100 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Quafeno soils that are relatively undisturbed. Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil is dark yellowish brown loam and dark brown very fine sandy loam about 20 inches thick. It is mottled in the lower part. The substratum is brown, mottled very fine sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Quafeno soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Quafeno soils that have been cut or graded.

Included with this complex in mapping are areas of Latourell, Quatama, and Sauvie soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderately slow and available water capacity is 9 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Quafeno soils have a water table within a depth of 3 feet during December to April. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are moderately slow permeability and a seasonal high water table. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

53B-Urban land-Quafeno complex, 3 to 8 percent slopes. This complex consists of Urban land and moder-

ately well drained Quafeno soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on short escarpment fronts of low terraces. Areas are generally long and narrow and are 15 to 50 acres in size. The Urban land and Quafeno soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 40 to 100 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Quafeno soils that are relatively undisturbed. Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil is dark yellowish brown loam and dark brown very fine sandy loam about 20 inches thick. It is mottled in the lower part. The substratum is brown, mottled very fine sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Quafeno soils that have been disturbed. These soils have been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Quafeno soils that have been cut or graded.

Included with this complex in mapping are areas of Latourell, Quatama, and Sauvie soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderately slow, and available water capacity is 9 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Quafeno soils have a water table within a depth of 3 feet during December to April. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are moderately slow permeability and wetness. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

53C-Urban land-Quafeno complex, 8 to 15 percent slopes. This complex consists of Urban land and moderately well drained Quafeno soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on short escarpment fronts of low terraces. Areas are generally long and narrow and are 15 to 50 acres in size. The Urban land and Quafeno soils are such an intricate pattern or so small in area, that to separate them in mapping was not practical. Elevation is 40 to 100 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Quafeno soils that are relatively undisturbed. Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil is dark yellowish brown loam and dark brown very fine sandy loam about 20 inches thick. It is mottled in the lower part. The substratum is brown, mottled very fine sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Quafeno soils that have been disturbed. These soils have been covered by as much as 40 inches of fill material, or as much as 60 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Quafeno soils that have been cut or graded.

Included with this complex in mapping are areas of Latourell, Quatama, and Sauvie soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderately slow and available water capacity is 9 to 12 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Quafeno soils have a water table within a depth of 3 feet during December to April. Runoff is medium, and the hazard of erosion is moderate.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are moderately slow permeability and a seasonal high water table. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation -are not provided.

This map unit is not assigned to a capability subclass.

54B-Urban land-Quatama complex, 3 to 8 percent slopes. This complex consists of Urban land and moderately well drained Quatama soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on short escarpment fronts of low terraces. Areas are generally long and narrow and are 15 to 50 acres in size. The Urban land and Quatama soils are in such an intricate pattern or so small in area that to separate them in mapping was not practical. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Quatama soils that are relatively undisturbed. Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam about 39 inches thick. It is mottled in the lower part. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Quatama soils that have been disturbed. This soil has been covered by as much as 30 inches of fill material, or as much as 40 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Quatama soils that have been cut or graded.

Included with this complex in mapping are areas of Cascade, Aloha, Powell, Quafeno, and Latourell soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderately slow and available water capacity is 8 to 10 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Quatama soils have a water table within a depth of 3 feet during December to April. Runoff is slow, and the hazard of erosion is slight.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are moderately slow permeability and a seasonal high water table. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal water table and droughty growing conditions should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

54C-Urban land-Quatama complex, 8 to 15 percent slopes. This complex consists of Urban land and moderately well drained Quatama soils. In most areas of this complex, the soils have been graded, cut, filled, or otherwise disturbed. This complex is on short escarpment fronts of low terraces. Areas are generally long and narrow and are 15 to 50 acres in size. The soils in this complex are in such an intricate pattern or so small in size that to separate them in mapping was not practical. Elevation is 75 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

About 50 percent of this complex is Urban land. The areas are largely covered by concrete, asphalt, buildings, or other impervious surfaces that so obscure or alter the soils that their identification is not feasible.

About 15 percent of this complex are areas of Quatama soils that are relatively undisturbed. Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark yellowish brown loam and clay loam about 39 inches thick. It is mottled in the lower part. The substratum is dark brown, mottled loam and sandy loam to a depth of 60 inches or more.

About 25 percent of this complex are areas of Quatama soils that have been disturbed. These soils have been covered by as much as 40 inches of fill material, or as much as 60 inches of the original profile has been removed by cutting or grading. The fill material is generally from adjacent areas of Quatama soils that have been cut or graded.

Included with this complex in mapping are areas of Cascade, Aloha, Powell, Quafeno, and Latourell soils. The included soils make up about 10 percent of this map unit.

In areas where the soils are relatively undisturbed, permeability is moderately slow and available water capacity is 8 to 10 inches. In areas dominated by cuts, fills, and Urban land, permeability and available water capacity are variable. Undisturbed areas of Quatama soils have a water table within a depth of 3 feet during December to April. Runoff is medium, and the hazard of erosion is moderate.

Areas of this complex that have not been disturbed include yards and openland around and between buildings. The main limitations for urban development are the moderately slow permeability and a seasonal high water table. Large areas of this map unit are artificially drained by sewer systems, gutters, drainage tiles, and surface ditches. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions

should be selected if drainage and irrigation are not provided.

This map unit is not assigned to a capability subclass.

55-Wapato silt loam. This poorly drained soil is on flood plains. This soil formed in recent alluvium. Slopes are 0 to 3 percent. Elevation is 100 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown, mottled silt loam about 12 inches thick. The subsoil is grayish brown, mottled silt loam about 33 inches thick. The substratum is dark greenish gray, mottled gravelly sandy clay loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aloha, Delena, Quatama, Powell, and Wollent soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is 10 to 12 inches. Water-supplying capacity is 17 to 19 inches. Runoff is slow, and the hazard of erosion is slight. From December through April, this soil is subject to a seasonal high water table at or near the surface and is subject to overflow from adjacent streams.

This soil is used for farming and wildlife habitat.

This soil is suited to farming. If it is drained, most climatically adapted crops do well. Irrigation during summer is required for maximum production of most crops. Major crops include grain, hay, pasture, and vegetables. Only hay and pasture species that can withstand periodic inundation and a high water table during winter are adapted to undrained areas. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping system help maintain fertility and tilth. Crops can be irrigated by sprinkler, furrow, or border systems; however, sprinklers are generally used to increase crop production in dry periods in summer. Grain and grasses respond to nitrogen. Legumes respond to phosphorus, boron, sulfur, and lime.

Native vegetation is red alder, black cottonwood, Oregon ash, willow, western redcedar, trailing blackberry, common snowberry, sedges, rushes, and grasses.

A wide variety of vegetation grows on this soil and furnishes good food and cover for ring-necked pheasant, California quail, mourning dove, and band-tailed pigeon. Habitat is also suitable for foxes, raccoon, opossum, squirrels, skunks, rabbits, mice, moles, gophers, muskrat, nutria, and mink. Nongame birds include hawks, owls, jays, crows, woodpeckers, flycatchers, hummingbirds, larks, robins, and many kinds of small birds.

This soil is severely limited for homesites and other urban uses. The main limitations for development are periodic flooding, moderately slow permeability, and a seasonal high water table. Dwellings and roads can be designed to offset these limitations if flood protection and sewers are provided. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a high seasonal water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited because of a seasonal high water table and flooding.

This soil is in capability subclass IIIw.

56E-Wauld very gravelly loam, 30 to 70 percent slopes. This well drained soil is in mountainous areas along the Columbia River. This soil formed in residuum and colluvium weathered from basalt. Elevation is 250 to 1,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the frost-free period is 145 to 200 days.

Typically, the surface layer is very dark brown very gravelly loam about 6 inches thick. The subsoil is very dark grayish brown and dark brown very gravelly clay loam about 24 inches thick. Depth to basalt is 30 inches.

Included with this soil in mapping are areas of Goble and Cascade soils, Haplumbrepts, very steep soils that are similar to Wauld soils but have bedrock at a depth of less than 20 inches, and soils that are similar to Wauld soils but have bedrock at a depth of 40 inches or more. The included soils make up as much as 20 percent of this map unit.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is 2 to 4 inches. Water-supplying capacity is 15 to 17 inches. Runoff is slow to medium, and the hazard of erosion is slight to high.

This soil is used for wildlife habitat, timber production, and recreational activities.

The vegetation is Douglas-fir, red alder, bigleaf maple, western redcedar, western hemlock, vine maple, creambush oceanspray, Cascade Oregon-grape, wild cherry, salal, swordfern, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 130 to 145. Based on a site index of 138, this soil is capable of producing about 9,440 cubic feet from a fully stocked stand of 70-year old trees, or 50,280 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including salal, Cascade Oregon-grape, vine maple, and red alder, restrict natural regeneration of Douglas-fir.

The main limitation for timber production is the high content of coarse fragments. Other limitations include bedrock at a depth of 20 to 40 inches. Some windthrow of trees occurs in places where rooting depth is restricted. Because of the steep slopes, such logging methods as aerial, high-lead, or skyline should be used for tree harvest. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

In the mild, high rainfall areas of the Coast Range Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and the availability of new plant growth. As new forest develops and most of the ground vegetation decreases, the deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for such species as Roosevelt elk, black bear, coyotes, bobcat, skunks, weasels, raccoon, mountain beaver, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, ruffed and blue grouse, mountain quail, band-tailed pigeon, and many small birds. Fur-bearing animals such as beaver, mink, and otter are common along larger streams. Most of the potential for wildlife habitat depends on the management of existing plant communities.

This soil has severe limitations for homesites and other uses. The major limitations for urban development are depth to bedrock, high concentration of coarse fragments, and slopes of 30 to 70 percent. Irrigation during summer is desirable for best results with grasses, shrubs, and trees. Mulching and fertilizing help establish plants in disturbed areas. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass VIIs.

57-Wollent slit loam. This poorly drained soil is on concave side slopes of broad rolling terraces. This soil formed in old alluvium. Elevation is 200 to 400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown, mottled silt loam about 10 inches thick. The subsoil is gray, mottled silt loam about 14 inches thick. The substratum is gray, mottled silty clay loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aloha, Powell, and Wapato soils. The included soils make up as much as 10 percent of this map unit.

Permeability is moderately slow. Available water capacity is 10 to 12 inches. Water-supplying capacity is 17 to 19 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight. A water table ranges from 12 inches above the surface to 12 inches below the surface from November through May.

This soil is used for farming, urban development and wildlife habitat.

This soil is suited to farming. If it is drained and irrigated, most climatically adapted crops do well. The major crops are berries, truck crops, nursery stock, hay, and pasture. Returning all crop residue to the soil helps maintain fertility and tilth. Where grain crops are grown, fertility can be maintained by cover crops, green-manure crops, and a cropping system that includes such soil-building crops as pasture or hay. A perched water table forms in this soil during rainy periods. Crops that require good drainage can be grown if a deep, random tile system is installed to remove the perched water. If the soil is to be left bare during winter, it should be fertilized and planted to a cover crop in fall.

Excessive cultivation can result in formation of a tillage pan in this soil. Subsoiling is required to break up this pan and is more successful if done when the soil is dry than when wet. Grain and grass crops need nitrogen. Legumes respond to phosphorus, lime, boron, and sulfur. Vegetable crops and berries respond to nitrogen, phosphorus, and potassium and in places, to sulfur.

The vegetation in areas not cultivated is western redcedar, Oregon ash, common snowberry, willow, roses, brackenfern, sedges, grasses, and forbs.

In areas not disturbed, this soil supports a rich mixture of trees, shrubs, and grasses that provides excellent food and cover for many wildlife species. Under the present monoculture, along with increasing demands for urban uses, this soil does not furnish a balanced distribution of cover and food for maximum wildlife population. The potential for wildlife habitat is good. Resident and seasonal wildlife using this area include ring-necked pheasant, California quail, mourning dove, band-tailed pigeon, foxes, raccoon, opossum, squirrels, skunks, rabbits, mice, moles, and gophers. Nongame birds include hawks, owls, jays, crows, woodpeckers, flycatchers, hummingbirds, larks, and many kinds of small birds.

Increased population growth has resulted in increased urban development on this soil. The main limitation for urban uses is a seasonal water table (fig. 21). Dwellings and roads can be designed to offset this limitation if sewers are provided. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Drainage is required for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetables, and irrigation during summer is desirable. Plants that tolerate a seasonal high water table and droughty conditions should be selected if drainage and irrigation are not provided. Recreational uses are limited by the seasonal high water table.

This soil is in capability subclass IIIw.

58D-Zygore gravelly loam, 5 to 30 percent slopes. This well drained soil is on broad ridgetops in mountainous areas. This soil formed in colluvium and glacial till from basalt and andesite mixed with volcanic ash. Elevation is 1,500 to 3,000 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free period is 30 to 100 days.

Typically, the surface layer is dark brown gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 14 inches thick. The substratum is

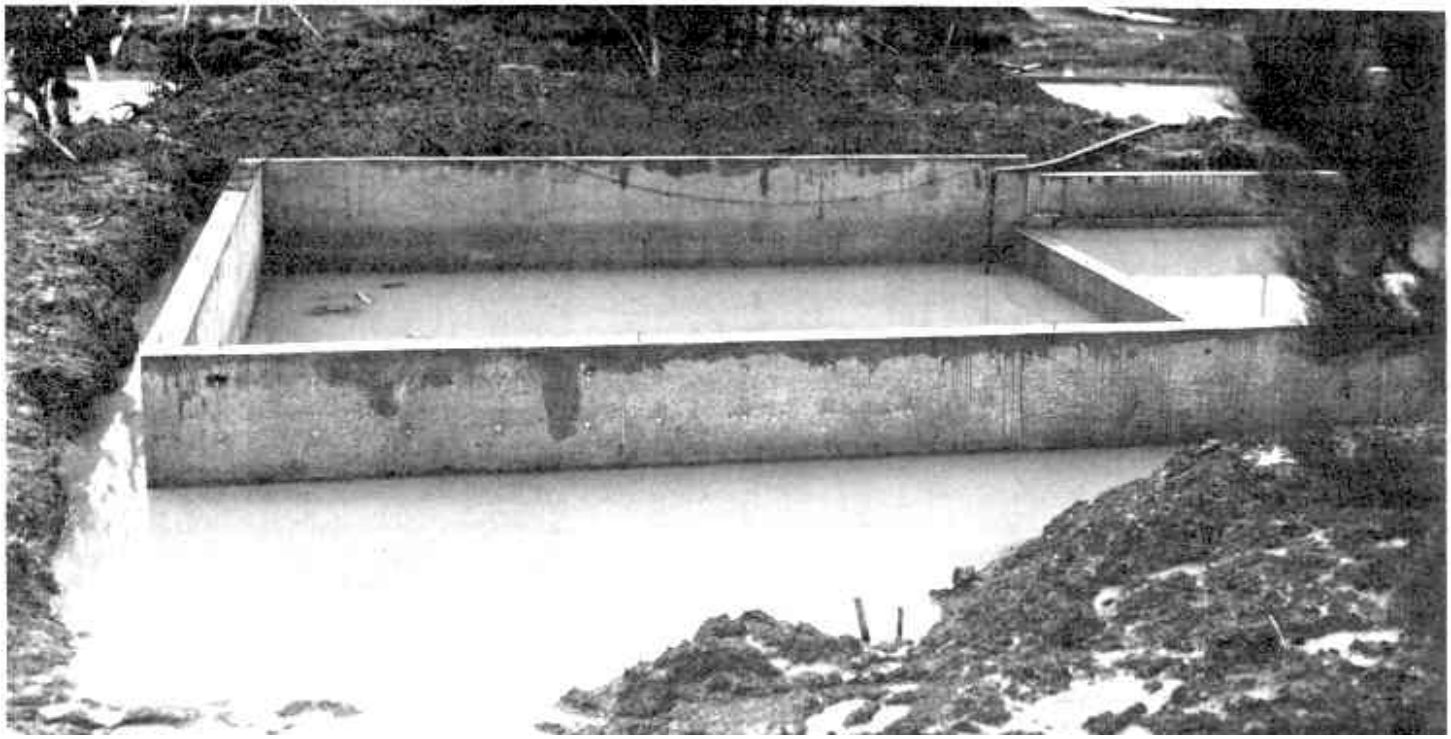

Figure 21.- Drainage problems develop if the water table is not controlled on Wollent silt loam.

dark brown very cobbly loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff soils, Rock outcrop, steeper Zygore soils, and soils that are similar to this Zygore soil but have bedrock at a depth of 20 to 60 inches. The included soils and miscellaneous areas make up as much as 20 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is medium, and the hazard of erosion is moderate.

This soil is mainly used for timber production, wildlife habitat, and water supply.

The vegetation is western hemlock, Douglas-fir (fig. 22), grand fir, red alder, western redcedar, vine maple, red huckleberry, salal, swordfern, Oregon oxalis, and forbs.

This soil is suited to Douglas-fir and western hemlock. The site index for Douglas-fir on this soil ranges from 160 to 170. Based on a site index of 165, this soil is capable of producing about 11,775 cubic feet from a fully stocked stand of 70-year old Douglas-fir trees, or 74,200 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80year old Douglas-fir trees. This soil is capable of producing about 105,750 board feet (Scribner rule) of merchantable timber from a fully stocked stand of 110-year old western hemlock trees. Brushy species, including vine maple, red alder and salal, restrict natural regeneration of Douglas-fir.

The main limitation for timber production is the high content of coarse fragments. When the soil is wet, the use of some conventional logging systems is limited. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

In the high rainfall areas on the western foot slopes of the Cascade mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and the availability of new plant growth in the form of trees, shrubs, and grasses. As new forest develops and most of the ground vegetation decreases, the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

This soil has moderate limitations for homesites and

Figure 22- Douglas-fir and western hemlock on Zygore gravelly loam, 5 to 30 percent slopes.

other uses. The main limitation for urban development is the high concentration of coarse fragments. Climatic conditions are severe. Winter is long and cold, summer is short and cool, and high winds occur during winter and spring. Only plants adapted to these severe weather conditions should be used for landscaping. Irrigation during summer is desirable for lawn grasses, shrubs, vines, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass VIs.

58E-Zygore gravelly loam, 30 to 60 percent slopes. This well drained soil is on broad ridgetops in mountainous areas. This soil formed in colluvium and glacial till from basalt and andesite mixed with volcanic ash. Elevation is 1,500 to 3,000 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free period is 30 to 100 days.

Typically, the surface layer is dark brown gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 24 inches thick. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of Aschoff soils, Rock outcrop, other Zygore soils, and soils that are similar to this Zygore soil but have bedrock at a depth of 20 to 60 inches. The included soils and miscellaneous areas make up as much as 20 percent of this map unit.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is medium, and the hazard of erosion is high.

This soil is mainly used for timber production, wildlife habitat, and water supply.

The vegetation is western hemlock, Douglas-fir, grand fir, red alder, western redcedar, vine maple, red huckleberry, salal, swordfern, Oregon oxalis, and forbs.

This soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 160 to 170. Based on a site index of 165, this soil is capable of producing about 11,925 cubic feet from a fully stocked stand of 70-year old trees, or 75,880 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, red alder, and salal, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are steep slopes and high content of coarse fragments. Because of steep slopes, such logging methods as aerial, highlead, or skyline should be used for tree harvest. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

In high rainfall areas on the western foot slopes of the Cascade Mountains, vegetation grows rapidly on this soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends on the clearing of land and availability of new growth of trees, shrubs, and grasses. As new forest develops most of the ground vegetation decreases, and the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for such other species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on the management of existing plant communities.

This soil has severe limitations for homesites and other uses. The main limitations for urban development are slopes of 30 to 60 percent and high concentration of coarse fragments. Climatic conditions are severe. Winter is long and cold, summer is short and cool, and high winds occur during winter and spring. Only plants adapted to these severe weather conditions should be used for landscaping and erosion control. Irrigation during summer is desirable for grasses, shrubs, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This soil is in capability subclass Vls.

59F-Zygore-Rock outcrop complex, 60 to 90 percent slopes. This well drained soil is on side slopes of canyons in mountainous areas. This soil formed in colluvium and glacial till from basalt and andesite mixed with volcanic ash. Elevation is 1,500 to 3,000 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free period is 30 to 100 days.

This complex is about 55 percent Zygore soils and 25 percent Rock outcrop. Included with this complex in mapping and making up as much as 20 percent of this map unit are areas of Aschoff soils, Rubble land, other Zygore soils, and soils that are similar to Zygore soils but have bedrock at a depth of 20 to 60 inches.

The Zygore soil has convex slopes and is between draws and areas of Rock outcrop. Typically, the surface layer is dark brown gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 24 inches thick. The substratum is dark brown very cobbly loam to a depth of 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is 4 to 6 inches. Water-supplying capacity is 21 to 26 inches. Runoff is rapid, and the hazard of erosion is high:

This complex is mainly used for timber production, wildlife habitat, and water supply.

The vegetation is western hemlock, Douglas-fir, grand fir, red alder, western redcedar, vine maple, red huckleberry, salal, swordfern, Oregon oxalis, and forbs.

The Zygore soil is suited to Douglas-fir. The site index for Douglas-fir on this soil ranges from 160 to 170. Based on a site index of 165, this soil is capable of producing about 11,925 cubic feet from a fully stocked stand of 70-year old trees, or 75,880 board feet (international rule, one-fourth inch kerf) of merchantable timber from a fully stocked stand of 80-year old trees. Brushy species, including vine maple, red alder, and salal, restrict natural regeneration of Douglas-fir.

The main limitations for timber production are the areas of Rock outcrop, slopes of 60 to 90 percent, and general inaccessibility of the areas. Because of the steep slopes, such methods of fogging as aerial, highlead or skyline should be used for tree harvest. Roads and landings need to be protected from erosion by constructing water bars and by seeding cuts and fills.

In high rainfall areas on the western foot slopes of the Cascade Mountains, vegetation grows rapidly on the Zygore soil. Vegetational stages change dramatically as a result of clear-cut logging and fires.

The potential for wildlife, especially black-tailed deer, depends upon the clearing of land and availability of new growth of trees, shrubs, and grasses. As new forest develops most of the ground vegetation decreases, and the black-tailed deer population returns to a low level. As the trees grow larger, species such as blue grouse are favored. Habitat is suitable for such species as Roosevelt elk, black bear, coyote, bobcat, cougar, skunks, weasels, mountain beaver, coney, marten, raccoon, mink, rabbits, and squirrels. Birds that are resident or seasonal include hawks, owls, jays, ravens, vultures, woodpeckers, grouse, mountain quail, band-tailed pigeon, and many small birds. Most of the potential for wildlife habitat depends on the management of existing communities.

This complex has severe limitations for homesites and other uses. The main limitations for urban development are slopes of 60 to 90 percent, areas of Rock outcrop, and high concentration of coarse fragments. Climatic conditions are severe. Winter is long and cold, summer is short and cool, and high winds occur during winter and spring. Only plants adapted to these severe weather conditions should be used for landscaping and erosion control. Irrigation during summer is desirable for grasses, shrubs, and most shade and ornamental trees. Mulching and fertilizing cut areas help establish plants. Plants that tolerate droughty conditions should be selected if irrigation is not provided.

This complex is in capability subclass Vlls.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area-the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and

other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, an others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 14. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience 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 yields were estimated by assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 14.

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 from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling 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 residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

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

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

Crops other than those shown in table 14 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops (29). The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are 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 rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability

and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at two levels: capability class and subclass. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

The capability subclass is identified in the description of each soil mapping unit in the section "Soil maps for detailed planning."

Woodland management and productivity

Terry A. Johnson, forester, Soil Conservation Service, assisted in writing this section.

This section gives interpretations for soils as they apply to woodland use and management. Commercial forest land occupies 41 percent of the survey area (9).

Forest land in the valley and foothills consists of Douglas-fir, western redcedar, and Oregon white oak. Ash and Oregon white oak occupy the poorly drained areas.

On the upper slopes of the foothills and on elevations up to 2,800 feet, the forest consists of Douglas-fir, western hemlock, western redcedar, and varying amounts of red alder and bigleaf maple. The amount of western hemlock increases as elevation increases. Pacific silver fir, noble fir, Douglas-fir, and western hemlock are on elevations up to 3,600 feet. Above 3,600 feet the forest consists of Pacific silver fir, noble fir, and mountain hemlock.

Douglas-fir and western redcedar are used for lumber, plywood, poles, and piling. Western redcedar is also used for posts and shingles. Alder and bigleaf maple are used mainly for furniture, whereas oak is used for fuel. Cascara bark is used for medicine. Hemlock and firs are used for lumber and pulp.

Hogan cedar, a rare variety of western redcedar, has a limited range. The range is mainly on Mershon soils and on the moderately steep and very steep Haplumbrepts. Hogan cedar is symmetrical and has a columnar or spire-like shape. A distinguishing feature between Hogan and western redcedar is the color between the top and underside of the leaf (18).

Table 15 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Mapping unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the ordination symbol, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t,* toxic substances in the soil; *d,* restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: x, w, t, d, c, s, f, and r.

In table 15 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal

limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of slight indicates that the expected mortality of the planted seedlings is less than 25 percent; moderate, 25 to 50 percent; and severe, more than 50 percent.

Considered in the ratings of *windthrow* hazard are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Douglas-fir was measured to indicate site index on soils at an elevation under 1,400 feet (17) and up to 3,600 feet (1Z). Noble fir was used to express site index at an elevation of about 3,600 feet (13).

Trees to plant are those that are suitable for commercial wood crops and are suited to the soils.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section.

The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment (4, 5, 10, 14, 24).

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 16 shows, for each kind of soil, the degree and kind of limitations for building site development; table 17, for sanitary facilities; and table 19, for water management. Table 18 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

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 16. A *slight* limitation indicates that soil properties generally 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 (14).

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. 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 given, 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 16 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does 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 hazard.

Local roads and streets referred to in table 16 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 (4, 5, 14).

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 are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields (15, 33), sewage lagoons, and sanitary landfills. 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 affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 17 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and 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 designs, or intensive maintenance is required. Soil suitability is rated by the terms good, fair, or poor, which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

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 absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard 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 the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material 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. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to 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, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 17 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation 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 in wet and dry periods. 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.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the 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, thickness of suitable soil material available and 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. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 18 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.

Roadfill is soil material used in embankments for roads (4). Soils are evaluated as a source of roadfill for low embankments, which generally are 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 where 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 the soil series.

The ratings apply to the soil material 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 their profile. The estimated engineering properties in table 22 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They 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 moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated poor.

Sand and *grave/* are used in great quantities in many kinds of construction. The ratings in table 18 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 22.

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 support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts 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 amounts 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 generally 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.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 19 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 best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the 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. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 20 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture

of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. Slight means that the soil properties are generally favorable and that the limitations are minor and easily overcome. Moderate means that the limitations can be overcome or alleviated by planning, design, or special maintenance. Severe means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 20 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 17, and interpretations for dwellings without basements and for local roads and streets, given in table 16.

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

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

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

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

Wildlife habitat

Robert A. Corthell, biologist, Soil Conservation Service, assisted in writing this section.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction 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, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

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

In table 21, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* 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 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. Moderately intensive management is 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 must be intensive. 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. 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 considerations. Examples of grain and seed crops are corn, sor-

ghum, wheat, oats, millet, buckwheat, cowpeas, sunflowers, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. 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 considerations. Examples of grasses and legumes are fescue, bluegrass, brome, timothy, orchardgrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. 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 considerations.

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. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are Oregon white oak, alder, ash, cherry, bigleaf maple, vine maple, dogwood, hazelnut, blackberry, and blueberry.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruit-like cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are Douglas-fir, western redcedar, western hemlock, and noble fir (fig. 23).

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that

Figure 23.-A mature stand of Douglas-fir and western hemlock forest type on Aschoff gravelly loam.

provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wet/and p/ants 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. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are cattails, rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. 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. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

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

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include blue and ruffed grouse, thrushes, woodpeckers, squirrels, fox, raccoon, deer, elk, and black bear.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, kingfishers, muskrat, mink, and beaver.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, mule deer, sage grouse, meadowlark, and lark bunting.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation (30). Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 22 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 22 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 22 in the standard terms used by the U.S. Department of Agriculture (28). These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (5) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (4).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index,

liquid limit, and organic-matter content. Soils are grouped into 15 classes-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 have a dual classification symbol, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified 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 an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 22. Also in table 22 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity *index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 23 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Clay is a mineral soil particle that is less than 0.002 millimeter in diameter. In table 23, the estimated clay content of each major soil horizon is given as a percent, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence the shrink-swell potential, permeability, and plasticity; the ease of soil dispersion; and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (oven dry) per unit volume. Volume is measured when the soil is at the field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C.

In table 23, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter for soil material that is less than 2 millimeters in diameter. The bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by the texture, kind of clay, content of organic matter, and structure of the soil.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field-particularly soil structure, porosity, and gradation or texture-that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 23, the estimated content of organic matter of the plow layer is expressed as a percent, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth of the soil. It is a source of nitrogen and other nutrients for crops.

Soil and water features

Table 24 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of 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; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

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 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 in table 24 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only 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 construction of basements is feasible and to determine how septic 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 a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. 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 200horsepower 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 soil, which causes ice lenses to form. 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.

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 moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material (24). The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Classification of the soils

This section describes the soil series of the survey area, defines the current system of classifying soils, and classifies the soils of the area according to that system.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (28). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil maps for detailed planning."

Aloha series

The Aloha series consists of very deep, somewhat poorly drained soils on broad, valley terraces. These soils formed in mixed alluvium or lacustrine silt. Slopes are 0 to 8 percent. The mean annual precipitation is about 55 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Aloha silt loam, 0 to 3 percent slopes, about 600 feet east of Troutdale Road, NE1/4NE1/4NW1/4 sec. 36, T. 1 N., R. 3 E.

A1-0 to 9 inches; dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; common fine irregular pores; common fine shot; medium acid; abrupt smooth boundary.

B1-9 to 15 inches; dark brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; common medium faint dark grayish brown (10YR 4/2) and brown (10YR 5/3) mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine and very fine tubular pores; medium acid; clear wavy boundary.

B21-15 to 25 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; common fine faint dark grayish brown (10YR 4/2), brown (10YR 5/3), and yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; firm, hard, slightly sticky and slightly plastic; common very fine roots; many medium fine and very fine tubular pores; few black coatings on peds; few fine hard concretions; medium acid; clear wavy boundary.

B22-25 to 35 inches; grayish brown (2.5YR 5/3) heavy silt loam, light brownish gray (10YR 6/2) dry; many medium distinct dark brown (7.5YR 4/4) and yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable, slightly hard, slightly sticky and slightly plastic; few very fine roots; many very fine and few fine tubular pores; common fine concretions; medium acid; gradual wavy boundary.

B3-35 to 48 inches; variegated brown and dark brown (10YR 5/3, 5/4, and 4/3) silt loam, pale brown .(10YR 6/3) dry; many medium and fine faint and distinct dark grayish brown (7.5YR 4/4) and reddish brown (5YR 4/8) mottles; weak coarse subangular blocky structure; slightly hard, firm, slightly sticky

and slightly plastic; brittle; few fine roots; many very fine and few fine tubular pores; common medium black coatings; common fine shot; common micaceous fragments; few thin clay films on vertical surfaces of peds; medium acid; gradual wavy boundary.

C-48 to 60 inches; yellowish brown (10YR 5/4) silt loam, pale brown (10YR 6/3) and dark yellowish brown (10YR 3/4) dry; common coarse brown (7.5YR 4/4) mottles and streaks; few black coatings; massive; firm, slightly sticky and slightly plastic; slightly brittle; few coarse and many fine and very fine tubular pores; medium acid.

The mean annual soil temperature ranges from 54 to 56 degrees F. The soil is generally moist, but in most years it is dry to a depth of 4 to 12 inches for 60 to 80 days. Depth to bedrock is more than 60 inches.

The A horizon has value of 5 or 6 dry and chroma of 2 or 3 moist or dry.

The B horizon has value of 4 or 5 moist. It has chroma of 3 or 4 above a depth of 20 inches and chroma of 2 to 4 below a depth of 20 inches. It has faint to distinct mottles throughout; mottles that have chroma of 2 or less are above a depth of 30 inches. The B horizon is silt loam or loam and has 18 to 27 percent clay and less than 15 percent material coarser than very fine sand. The lower part of the B horizon ranges from slightly brittle to a fragipan that is very weak and has few to continuous coatings of clean, gray sand and silt grains. The B horizon has a few thin or thin and continuous clay and organic coatings, but it does not have an appreciable increase in clay content over the A horizon.

The C horizon is silt loam, loam, or very fine sandy loam.

Aschoff series

The Aschoff series consists of deep, well drained soils in mountainous areas. These soils formed in colluvium from basalt and andesite mixed with volcanic ash (fig. 24). Slopes are 5 to 90 percent. The mean annual precipitation is about 80 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Aschoff cobbly loam, along Palmer Mill Road, SE1/4SW1/4SE1/4 sec. 22, T. 1 N., R. 5 E.

O1-4 inches to 1 inch; needles, twigs, leaves, and cones; partially decomposed in the lower part.

O2-1 inch to 0; black (10YR 2/1) amorphous organic matter; abrupt smooth boundary.

A1-0 to 6 inches; very dark brown (7.5YR 3/2) cobbly loam, dark brown (7.5YR 4/2) dry; moderate fine and very fine subangular blocky structure; ped surfaces are very dark brown (10YR 2/2); slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine and fine irregular and tubular pores; 15 percent pebbles, 15 percent cobbles; medium acid; clear wavy boundary.

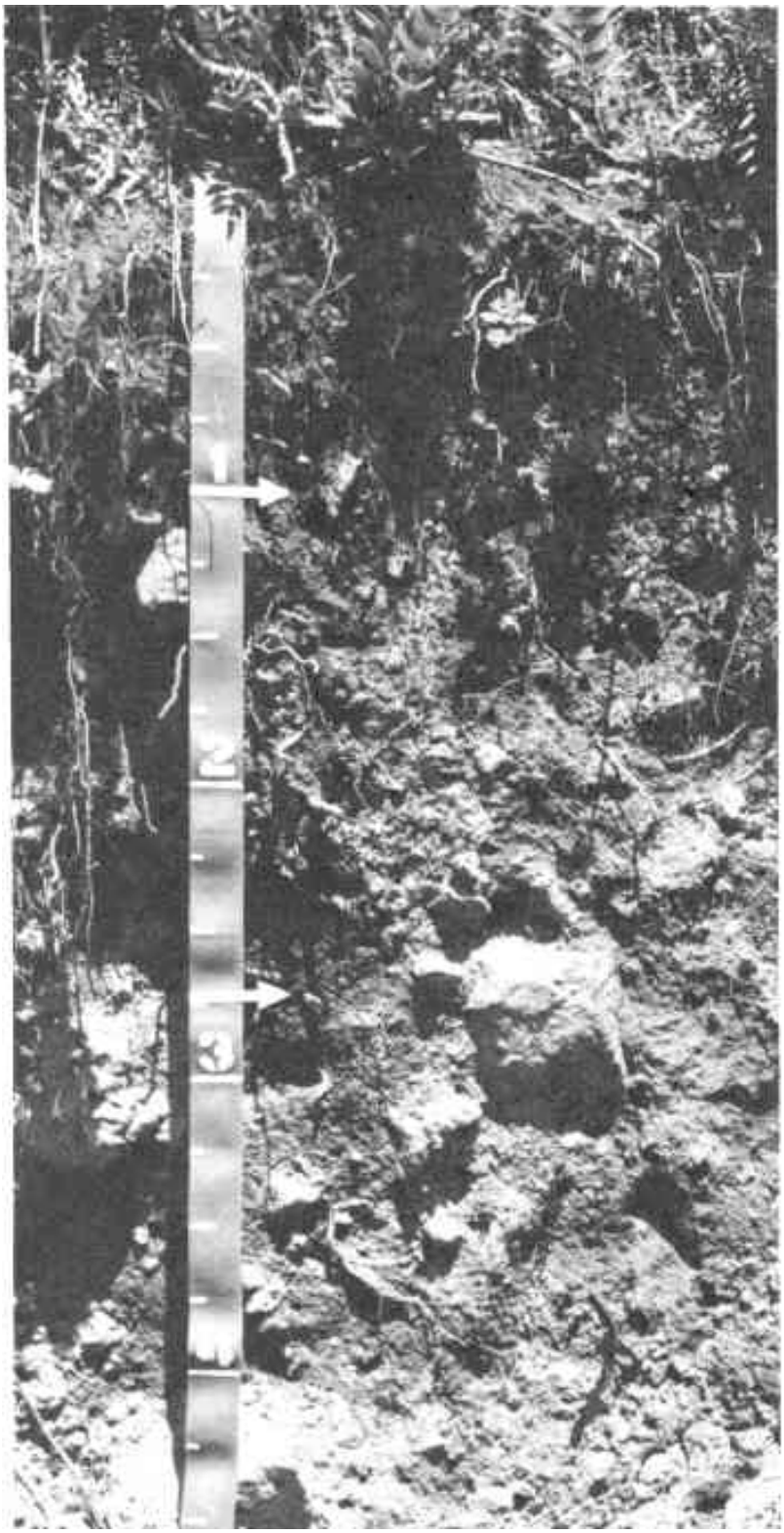

Figure 24.-Profile of Aschoff cobbly loan formed in deep cobbly colluvium.

A3-6 to 12 inches; dark brown (7.5YR 3/3) cobbly loam, dark brown (7.5YR 4/3) dry; moderate fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine and fine irregular and tubular pores; 15 percent cobbles, and 15 percent pebbles; medium acid; clear wavy boundary.

B2-12 to 23 inches; dark brown (7.5YR 3/4) very cobbly loam, brown (7.5YR 4/4) dry; moderate fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many very fine and fine irregular and tubular pores; 25 percent cobbles, 15 percent pebbles, 10 percent stones; medium acid; gradual wavy boundary.

B3-23 to 34 inches; dark brown (7.5YR 3/4) very cobbly loam, brown (7.5YR 4/4) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine and fine interstitial and tubular pores; 25 percent cobbles, 20 percent pebbles, 10 percent stones; medium acid; gradual wavy boundary.

C-34 to 60 inches; dark brown (7.5YR 4/4) very cobbly loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; many very fine and fine interstitial and tubular pores; 30 percent cobbles, 20 percent pebbles, 5 percent stones; slightly acid.

The mean annual soil temperature ranges from 50 to 54 degrees F. The soil has a udic moisture regime but has a short dry period of less than 45 consecutive days during summer. The solum has hue of 10YR, 7.5YR, or 5YR. Depth to bedrock or highly fractured bedrock is more than 60 inches.

The A horizon has value of 2 or 3 moist and chroma of 2 or 3 moist or dry. It has 15 to 30 percent pebbles and 5 to 20 percent cobbles.

The B horizon has value of 3 or 4 moist and 4 or 5 dry. It is loam or silt loam and is very cobbly or extremely cobbly. It has 15 to 25 percent pebbles and 20 to 45 percent cobbles.

The C horizon has value of 3 or 4 moist and 5 or 6 dry and chroma of 3 or 4 moist or dry. It is loam or sift loam and has 15 to 25 percent pebbles and 20 to 45 percent cobbles.

Bull Run series

The Bull Run series consists of very deep, well drained soils on rolling ridgetops. These soils formed in silty material mixed with volcanic ash. Slopes are 3 to 80 percent. The mean annual precipitation is about 70 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Bull Run silt loam, 3 to 8 percent slopes, about 100 feet north of Larch Mountain Road NE1/4SE1/4NE1/4 sec. 5, T. 1 S., R. 5 E.

O1-2 inches to 0; twigs, needles, leaves, and cones.

A1-0 to 4 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; very fine and fine subangular blocky structure and fine granular; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and very fine irregular and tubular pores; 10 percent concretions 2 to 10 millimeters in diameter; medium acid; clear wavy boundary.

A3-4 to 10 inches; very dark grayish brown (7.5YR 3/2) silt loam, brown (7.5YR 5/3) dry; strong very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and few medium roots; many fine and very fine tubular pores; 5 percent concretions, 2 to 10 millimeters in diameter; medium acid; clear wavy boundary.

B21-10 to 19 inches; dark yellowish brown (7.5YR 3/3) silt loam, yellowish brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many fine and very fine tubular pores; medium acid; gradual wavy boundary.

B22-19 to 36 inches; dark yellowish brown (7.5YR 4/4) silt loam, yellowish brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; many fine and very fine tubular pores; medium acid; clear wavy boundary.

C-36 to 60 inches; dark yellowish brown (7.5YR 4/4) silt loam, light yellowish brown (7.5YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; medium acid.

The mean annual soil temperature ranges from 50 to 54 degrees F. The soil has a udic moisture regime but has a short dry period of less than 45 consecutive days during summer. Thickness of the solum ranges from 30 to 60 inches. Depth to bedrock is 60 inches or more. The profile to a depth of 60 inches is silt loam and has measured clay content of about 12 to 18 percent; the ratio of clay to 15-bar water is 1.0 or less; and the bulk density is about .70 to .85 grams per cubic centimeter in the upper 2 feet of the profile. The average 15-bar water retention is about 15 to 20 percent in the 10- to 40-inch control section. The soil is medium to strongly acid. The umbric epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 moist and 3 to 5 dry and has chroma of 2 moist or dry. It has moderate or strong, fine and very fine, subangular blocky structure.

The B horizon has value of 3 in the upper part and 3 or 4 in the lower part moist and 5 or 6 dry. It has chroma of 3 in the upper part and 4 in the lower part moist or 4 dry. This horizon has weak or moderate, very fine to medium subangular blocky structure.

The C horizon is mostly silt loam but is gravelly glacial till below a depth of 40 inches in some pedons.

Burlington series

The Burlington series consists of very deep, somewhat excessively drained soils on low terraces along the Columbia River and its tributaries. These soils formed in alluvium. Slopes are 0 to 15 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Burlington fine sandy loam, about 1 mile northwest of Reeder Road junction, SW1/4NW1/4SW1/4 sec. 8, T. 2 N., R. 1 W.

Ap1-0 to 4 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; common fine roots; many fine interstitial pores; slightly acid; abrupt smooth boundary.

Ap2-4 to 12 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; many fine interstitial pores; slightly acid; clear smooth boundary. C1-12 to 48 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; massive; loose, very friable, nonsticky and nonplastic; few fine roots; many fine interstitial pores; neutral gradual smooth boundary.

C2-48 to 60 inches; dark yellowish brown (10YR 4/4) loamy fine sand, yellowish brown (10YR 5/4) dry; single grain; loose, very friable, nonsticky and nonplastic; many fine interstitial pores; neutral.

The mean annual soil temperature ranges from 53 to 55 degrees F. The mollic epipedon is 10 to 14 inches thick. The soil is generally moist, but in most years it is dry to a depth of 4 to 12 inches for 60 to 80 days. The soil is slightly acid in the surface layer and neutral in the subsoil.

The A horizon is fine sandy loam or sandy loam.

The C horizon has chroma of 3 or 4 and hue of 10YR. It is loamy fine sand or fine sand.

Cascade series

The Cascade series (fig. 25) consists of moderately deep, somewhat poorly drained soils on broad rolling ridgetops. These soils formed in silty materials. Slopes are convex and are 3 to 60 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Cascade silt loam, about 25 feet north of Skyline Boulevard, SW1/4SE1/4NE1/4 sec. 10, T. 2 N., R. 2 W.

A1-0 to 8 inches; dark brown (7.5YR 3/2) silt loam, brown (10YR 5/3) dry; strong fine granular structure and very fine subangular blocky; friable, slightly sticky and slightly plastic; many very fine and few fine to coarse roots; many very fine irregular pores;

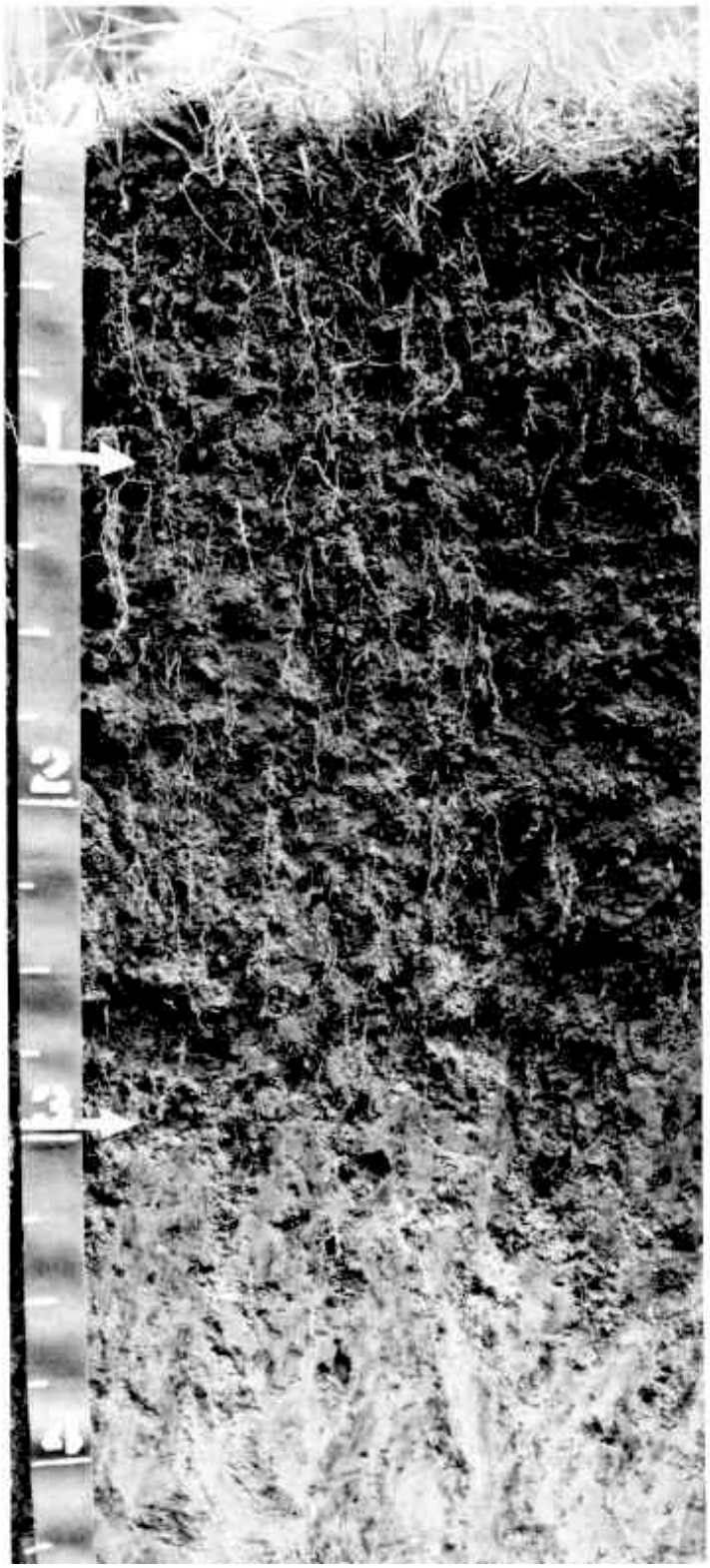

Figure 25-Profile of Cascade silt loam underlain by a fragipan at a depth of 30 inches.

10 percent fine concretions; 10 percent pebbles; medium acid; clear smooth boundary.

B21-8 to 16 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 5 percent fine concretions; medium acid; clear wavy boundary.

B22-16 to 27 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few fine and coarse roots; many very fine tubular pores; common fine concretions; very firm peds; medium acid; clear wavy boundary.

IIBx1-27 to 35 inches; dark brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; 10 percent brown (7.5YR 2/2) silt loam tongues, strong brown (7.5YR 5/6) mottles at margins of tongues; weak coarse prismatic structure parting to moderate fine subangular blocky; firm, brittle, hard, slightly sticky and plastic; few fine and medium roots; many very fine tubular pores; few fine concretions; few fine black stains; strongly acid; clear, wavy boundary.

IIBx2-35 to 45 inches; dark brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; 20 percent brown (7.5YR 5/2) tongues, brown and strong brown (7.5YR 5/4 and 5/6) mottles at margins of tongues; weak coarse prismatic structure and weak medium blocky; very firm, brittle, very hard, slightly sticky and plastic; few very fine roots; few very fine tubular pores; few thin and moderately thick clay films in pores and on faces of peds; common medium and coarse black stains; strongly acid; clear irregular boundary.

IIBx3-45 to 60 inches; dark brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; 10 percent brown (7.5YR 5/2) tongues, brown and strong brown (7.5YR 5/4 and 5/6) mottles at margins of tongues; weak coarse prismatic structure; very firm, brittle, very hard, slightly sticky and slightly plastic; few very fine tubular pores; few thin and moderately thick clay films on faces of peds; few fine black stains; medium acid.

The soil is generally moist, but in summer it is dry throughout to a depth of 4 to 12 inches for about 45 to 60 consecutive days. The mean annual soil temperature ranges from 52 to 54 degrees F. The depth to the fragipan ranges from 20 to 30 inches. A perched water table is above the fragipan during winter. The umbric epipedon ranges from 10 to 19 inches in thickness.

The A horizon has hue of 7.5YR or 10YR and chroma of 2 or 3 moist.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry. It is silt loam or light silty clay loam and has 18 to 30 percent clay. This horizon has less than 10 percent material coarser than very fine sand.

The underlying fragipan ranges from 2 to more than 4 feet in thickness. It has mottles and tongues that have chroma of 2. The fragipan is firm or very firm and hard or very hard. Clay films are few or common and thin or moderately thick on the fractures and in pores in the fragipan. Few rock fragments of basalt are at or near the upper boundary of the fragipan.

Cazadero series

The Cazadero series consists of deep, well drained soils on terraces. These soils formed in old alluvium. Slopes are 0 to 60 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 51 degrees F.

The Cazadero soils in Multnomah County are not as red as Cazadero soils in other areas, but this does not affect the use and management of these soils.

Typical pedon of Cazadero silty clay loam, about 100 feet north of Gordon Creek Road, SE1/4SE1/4NW1/4 sec. 24, T. 1 S., R. 4 E.

A1-0 to 10 inches; very dark brown (7.5YR 2/2) silty clay loam, dark 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 concretions 2 to 10 millimeters in diameter; strongly acid; clear smooth boundary.

A3-10 to 16 inches; dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B21t-16 to 23 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; common thin clay films on peds; strongly acid; gradual wavy boundary.

B22t-23 to 52 inches; reddish brown (5YR 4/4) silty clay, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many very fine tubular pores; many moderately thick clay films on peds and in pores; strongly acid; gradual wavy boundary.

B3t-52 to 60 inches; yellowish red (5YR 4/6) silty clay; weak coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine tubular pores; common thin clay films on peds; strongly acid.

The soil is generally moist, but in places during summer it is dry to a depth of 4 to 12 inches for less than 45 consecutive days. The mean annual soil temperature ranges from 52 to 54 degrees F. Depth to bedrock is more than 60 inches.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 moist, and chroma of 2 or 3 moist or dry.

The B horizon has hue of 2.5YR or 5YR, value of 3 moist and 4 dry, and chroma of 4 to 6 moist or dry. It is silty clay or clay and has an average 45 to 55 percent clay in the upper 20 inches of the argillic horizon. This horizon is underlain by variegated, weathered rock or andesite.

Cornelius series

The Cornelius series consists of deep, moderately well drained soils on uplands. These soils are on low hills where slopes are long and convex and on ridgetops. These soils formed in silty materials over mixed old alluvium. Slopes are 3 to 60 percent. The mean annual precipitation is 40 to 60 inches, and the mean annual air temperature is 52 to 54 degrees F.

Typical pedon of Cornelius silt loam, 3 to 8 percent slopes, 50 feet north of road, SW1/4SW1/4SE1/4 sec. 31, T. 1 S., R. 1 E.

A1-0 to 8 inches; dark brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine and few medium roots; many very fine irregular pores; many fine concretions; medium acid; clear wavy boundary.

B11-8 to 14 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; many very fine tubular pores; thin silt coatings on some peds; few fine concretions; medium acid; clear wavy boundary.

B12-14 to 20 inches; brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; thin grayish brown silt coatings on peds; medium acid; clear wavy boundary.

B21t-20 to 28 inches; brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular pores; common moderately thick clay films in pores; strongly acid; clear wavy boundary.

B22t-28 to 33 inches; brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular pores; common moderately thick clay films on peds and in pores; few fine black manganese stains; strongly acid; clear wavy boundary.

Bxt-33 to 48 inches; brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; grayish brown (10YR 5/2) tongues and coatings in fractures; reddish brown (5YR 4/4) mottles in fracture margins; weak coarse subangular blocky structure; brittle, very firm, sticky and plastic; few fine roots; many very fine tubular pores; many moderately thick clay films on peds and in pores; common fine black manganese stains; strongly acid; gradual wavy boundary.

Cx-48 to 60 inches; brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) and very pale brown (10YR 8/3) dry; grayish brown (10YR 5/2) tongues, mottles, and coatings; massive with some vertical fractures; brittle, firm, sticky and plastic; many very fine tubular pores; common moderately thick clay films in pores and on fracture faces; common fine black manganese stains; strongly acid.

The soil is generally moist, but in most years it is dry throughout to a depth of 4 to 12 inches for 45 to 75 consecutive days. The mean annual soil temperature ranges from 52 to 56 degrees F. The depth to the fragipan ranges from 30 to 40 inches. Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 moist and chroma of 2 or 3 moist.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 to 7 dry, and chroma of 3 or 4 moist or dry. It is dominantly silty clay loam and has 27 to 35 percent clay and less than 15 percent material coarser than very fine sand. Near the boundary of the fragipan in some pedons, this horizon has a few, faint mottles that have hue of 5YR or 7.5YR and chroma of 3 or 4. It has common to nearly continuous or thin to moderately thick clay films on most peds.

The Bxt horizon has matrix colors similar to those in the horizon above it, but it has faint to prominent mottles that have chroma of more than 2 and has tongues that have chroma of 2. The Bxt horizon is commonly 2 feet or more in thickness. This horizon is firm and brittle and has few to many thin to moderately thick clay films on many peds. It overlies a dark reddish brown (2.5YR 3/4) clay soil in some areas.

Cryofibrist

Cryofibrist consists of moderately deep to very deep, very poorly drained, organic soils in long, narrow, concave areas. These soils formed in woody and herbaceous plant materials and are saturated most of the year. Slopes are 0 to 1 percent. The mean annual precipitation is about 120 inches, and the mean annual air temperature is about 43 degrees F.

A reference profile representing a Cryofibrist, SW1/4SW1/4 sec. 24, T. 1 N., R. 6 E.

Oi1-0 to 7 inches; very dark brown (10YR 2/2) rubbed and unrubbed undecomposed fibric materials; about 85 percent fibers, 65 percent fibers after rubbing; massive; very strongly acid; diffuse wavy boundary. Oi2-7 to 45 inches; dark reddish brown (5YR 3/2 and 3/4) unrubbed and dark reddish brown (5YR 2/2)

rubbed undecomposed fibric materials; about 85 percent fibers, 50 percent fibers after rubbing; massive; very strongly acid; diffuse wavy boundary.

Oi3-45 to 55 inches; dark reddish brown (5YR 2/2) unrubbed and dark reddish brown (5YR 3/3) rubbed undecomposed fibric materials; about 50 percent fibers, 28 percent fibers after rubbing; massive; strongly acid; diffuse wavy boundary.

Oi4-55 to 65 inches; dark reddish brown (5YR 2/2) rubbed and unrubbed undecomposed fibric materials; about 20 percent fibers, 5 percent fibers after rubbing; massive; strongly acid.

The mean annual soil temperature ranges from 40 to 47 degrees F. In areas, the soil is saturated with water the year around, but where the soil is shallow to bedrock or cemented glacial till it is dry during periods. Depth to bedrock or cemented till is 15 to 60 inches or more. In places, lenses of mineral soil are below a depth of 7 inches. The soil is extremely acid to strongly acid.

Dabney series

The Dabney series consists of very deep, somewhat excessively drained soils on long, narrow terraces. These soils formed in sandy alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Dabney loamy sand, about 100 feet west of Oxbow Park Road, NE1/4SW1/4SE1/4 sec. 10, T. 1 S., R. 4 E.

A1-0 to 3 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine and very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; strongly acid; abrupt, smooth boundary.

AC-3 to 15 inches; very dark grayish brown (10YR 3/2) medium sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 15 percent pebbles in thin lenses; strongly acid; clear smooth boundary.

C1-15 to 30 inches; dark gray (10YR 4/1) coarse sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; 15 percent pebbles; common very fine roots; many fine irregular pores; medium acid; clear smooth boundary.

C2-30 to 60 inches; dark gray (10YR 4/1) medium sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; many very fine irregular pores; medium acid.

The mean annual soil temperature ranges from 51 to 53 degrees F. The soil has a udic moisture regime but has a short dry period of less than 45 consecutive days during summer. Depth to bedrock is 60 inches or more.

The A horizon has value of 2 or 3 moist and chroma of 2. It has weak granular or subangular blocky structure. The C horizon has hue of 10YR, value of 4 or 5 moist, and chroma of 1 or 2. This horizon is fine or medium sand over coarse sand or gravelly coarse sand and has as much as 30 percent pebbles. It has common, distinct, reddish brown and gray mottles.

Delena series

The Delena series consists of deep, poorly drained soils on uplands. These soils formed in silty material. Slopes are concave and are 3 to 12 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Delena silt loam, 3 to 12 percent slopes, 300 feet west of Skyline Boulevard, SW1/4SW1/4NW1/4 sec. 24, T. 2 N., R. 2 W.

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; common fine very hard concretions; medium acid; clear smooth boundary.

A12-7 to 13 inches; very dark grayish brown (10YR 3/2) heavy silt loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine roots; many very fine tubular pores; common fine very hard concretions; medium acid; clear smooth boundary.

B1-13 to 18 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; many fine prominent dark reddish brown and reddish brown (5YR 3/3 and 4/4) mottles; moderate fine subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; common very fine soft concretions; medium acid; clear smooth boundary.

B2-18 to 23 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/1) dry; many fine prominent reddish brown (5YR 4/4) mottles; moderate fine subangular blocky structure; hard, firm and slightly sticky and plastic, slightly brittle; few fine roots; common very fine pores; slightly acid; clear smooth boundary.

IIBx1-23 to 33 inches; grayish brown (10YR 5/2) light silty clay, light gray (10YR 7/1) dry; many fine prominent reddish brown (5YR 4/4) and yellowish red (5YR 4/6) mottles; weak coarse prismatic structure parting to blocky; hard, brittle, sticky and plastic; common very fine tubular pores; common moderately thick clay films in pores, channels, and on a few ped surfaces; slightly acid; clear smooth boundary.

IIIBx2-33 to 60 inches; variegated yellowish red (5YR 4/6), dark grayish brown (10YR 4/2), and grayish

brown (2.5Y 5/2) silty clay loam; weak coarse prismatic structure parting to blocky; hard, slightly brittle, slightly sticky and plastic; common very fine tubular pores; moderately thick clay films in pores and on a few ped surfaces; neutral.

The soil is saturated during winter and spring, unless artificially drained. In places during summer, the soil is dry for short periods. Rooting depth is restricted by a seasonal high water table at a depth of less than 30 inches. Depth to the fragipan is 20 to 30 inches. The mean annual soil temperature ranges from 51 to 55 degrees F.

The A horizon has value of 2 or 3 moist and 4 or 5 dry and chroma of 1 or 2 moist or dry. It has granular or subangular blocky structure.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 moist and 6 or 7 dry, and chroma of 2 moist and 1 or 2 dry. It has distinct or prominent mottles.

The Bx horizon has hue of 10YR or 2.5Y, value of 4 or 5 moist and 6 or 7 dry, and chroma of 1 or 2 moist or dry. It has lower chroma and yellower hue on coatings on peds and tongues. This horizon is firm or very firm and commonly brittle. It has common to many and thin to moderately thick clay films in pores and on cleavage planes or polygonal cracks.

Divers series

The Divers series consists of deep, well drained soils on uplands. These soils formed in mixed ash and colluvial material weathered from basalt and andesite. Slopes are 5 to 60 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Divers gravelly silt loam, 300 feet north of junction between Mt. Talapus Road and Moffitt Trail, 50 feet west of road, NW1/4NW1/4 sec. 17, T. 1 N., R7 E.

O1-2 inches to 0; needles, twigs, cones, and leaves. A1-0 to 4 inches; dark brown (7.5YR 3/2) gravelly silt loam, brown (7.5YR 5/2) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine irregular pores; many fine and very fine roots; 20 percent pebbles, 5 percent cobbles; strongly acid; gradual smooth boundary.

B1-4 to 14 inches; brown (7.5YR 4/4) gravelly silt loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine tubular pores; many fine and very fine roots; 20 percent pebbles, 10 percent cobbles; strongly acid; clear wavy boundary.

B21-14 to 28 inches; dark brown (7.5YR 4/3) very cobbly loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common fine roots; many very fine tubular pores; 20 percent cobbles, 15 percent pebbles; medium acid; gradual wavy boundary.

B22-28 to 44 inches; brown (7.5YR 4/4) very cobbly loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; 45 percent cobbles, 20 percent pebbles; medium acid; clear, wavy boundary.

C-44 to 60 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots; many very fine tubular pores; 50 percent cobbles, 30 percent pebbles; medium acid.

The soil is generally moist, but in most years it is dry throughout the moisture control section for less than 45 consecutive days. The mean annual soil temperature ranges from 40 to 44 degrees F. The mean summer soil temperature is less than 47 degrees if this soil has an O horizon, and it is less than 59 degrees if the soil does not have an O horizon. Depth to bedrock is 60 inches or more. The fine earth fraction of the solum contains 20 to 60 percent ash or other pyroclastic material. The rock fragments in the 10- to 40-inch section range from 35 to 85 percent. The solum ranges from 25 to 50 inches in thickness. Hue ranges from 5YR to 7.5YR.

The A horizon has value of 2 or 3 moist and chroma of 2, 3, or 4 moist or dry. It is 20 to 40 percent pebbles and 5 to 10 percent cobbles. This horizon has weak or moderate granular structure.

The B horizon has value of 5 or 6 dry, 3 or 4 moist, and chroma of 3 or 4 moist or dry. It has less than 18 percent clay and has 25 to 40 percent pebbles and 10 to 45 percent cobbles. This horizon has weak or moderate granular or subangular blocky structure.

The C horizon below a depth of 40 inches has hue of 7.5YR or 10YR. It has 40 to 55 percent cobbles and 20 to 30 percent pebbles.

Faloma series

The Faloma series consists of very deep, poorly drained soils on broad flood plains. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Faloma silt loam, about 100 yards from the mouth of the Sandy River on the east bank, SE1/4NE1/4SE1/4 sec. 14, T. 1 N., R. 3 E.

A11-0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine prominent yellowish red (5YR 4/8) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine

tubular pores; medium acid; abrupt smooth boundary.

A12-3 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine prominent yellowish red (5YR 4/8) mottles; moderate medium subangular blocky structure; hard, friable, nonsticky and nonplastic; many very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B2-10 to 15 inches; dark gray (10YR 4/1) silt loam, light brownish gray (10YR 6/2) dry; many fine and medium prominent yellowish red (5YR 4/8) mottles; moderate medium and coarse subangular blocky structure; very hard, friable, nonsticky and nonplastic; Common very fine roots; common very fine tubular pores; medium acid; clear wavy boundary.

IIC-15 to 60 inches; variegated mottled dark gray (10YR 4/1), reddish brown (5YR 5/4), dark reddish gray (10YR 4/1), and dusky red (10R 3/4) sand; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; medium acid.

The soil is saturated above a depth of 60 inches for many months each year. In places during summer, the soil is dry to a depth of 4 to 12 inches for short periods. The mean annual soil temperature ranges from 54 to 56 degrees F. Thickness of the solum and depth to sand range from 14 to 20 inches. The soil is slightly acid to medium acid.

The A horizon is 10 to 20 inches thick and has faint to prominent mottles. It has value of 2 or 3 moist and 4 or 5 dry and chroma of 1 or 2 moist or dry.

The B horizon has hue of 10YR or 2.5Y, value of 3 or 4 moist and 5 or 6 dry, and chroma of 1 or 2 moist or dry. It has distinct or prominent mottles. This horizon is silt loam, loam, or very fine sandy loam and has weak or moderate structure.

The C horizon is loamy fine sand to coarse sand. It has distinct or prominent mottles. This horizon has as much as 10 percent pebbles in some pedons.

Goble series

The Goble series consists of very deep, moderately well drained soils on long, convex side slopes and ridgetops on uplands. These soils formed in silty materials. Slopes are 3 to 60 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Goble silt loam, about 30 feet west of Skyline Boulevard, NW1/4NE1/4NE1/4 sec. 3, T. 2 N., R. 2 W.

AO-1 /4 inch to 0; needles, twigs, moss, and leaves.

A1-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; strong fine granular structure; soft, friable, slightly sticky and slightly plastic; many fine roots; many fine and very fine irregular pores; many fine concretions; medium acid; abrupt smooth boundary.

A3-7 to 14 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; strong fine granular structure; soft, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; few fine concretions; strongly acid; clear smooth boundary.

B1-14 to 26 inches; dark brown (7.5YR 3/4) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine and few medium roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B21-26 to 37 inches; dark brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; slightly hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; strongly acid; abrupt smooth boundary.

IIBx-37 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; many fine and medium distinct dark brown (7.5YR 3/2), strong brown (7.5YR 5/6), and light gray (10YR 7/1) mottles and light gray (10YR 7/1) tongues in fracture planes; numerous fine and medium black stains; weak very coarse prismatic and medium blocky structure and subangular blocky; hard, brittle, very firm, sticky and plastic; common very fine tubular pores; common thin clay films in fractures and on prism faces; very strongly acid.

The soil has a udic moisture regime but has a dry period of less than 45 days during summer. The mean annual soil temperature ranges from 47 to 55 degrees F. Depth to the fragipan ranges from 30 to 48 inches. Depth to bedrock is more than 60 inches. The umbric epipedon is 10 to 20 inches thick.

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

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4. It is typically silty clay loam, but in the upper part in places it is silt loam. Near the boundary of the fragipan in some pedons, this horizon has a few faint mottles that have chroma of 3 or 4 and hue of 5YR.

The Bx horizon (fragipan) has matrix colors similar to colors in the horizons above it but has distinct and prominent mottles that have chroma of 2. This horizon is hard, very firm, and brittle. It has common or continuous and thin clay films on prism faces and in fractures. The fragipan is commonly more than 1 foot thick and overlies old alluvium or loess and residual material of mixed origin.

Goodlow series

The Goodlow series consists of very deep, well drained soils on uplands. These soils formed in mixed

ash and colluvial material weathered from basalt and andesite. Slopes are 5 to 60 percent. The mean annual precipitation is about 80 inches, the mean annual air temperature is about 43 degrees F.

Typical pedon of Goodlow gravelly silt loam, along Larch Mountain Road, SE1/4NE1/4 sec. 32, T. 1 N., R. 6 E.

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

A1-0 to 3 inches; dark brown (7.5YR 3/2) gravelly silt loam, brown (10YR 5/3) dry; moderate fine and medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many fine and very fine irregular pores; 15 percent pebbles, 5 percent cobbles; strongly acid; clear smooth boundary.

A3-3 to 10 inches; dark brown (7.5YR 3/2) gravelly silt loam, brown (10YR 5/3) dry; moderate medium and coarse granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and medium roots; many fine and very fine irregular pores; 15 percent pebbles, 5 percent cobbles; strongly acid; clear wavy boundary.

B2-10 to 34 inches; brown (10YR 4/3) very cobbly clay loam, pale brown (10YR 6/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few thin clay films in pores; common fine roots; many fine and very fine tubular pores; 35 percent pebbles, 20 percent cobbles, 5 percent stones; strongly acid; clear irregular boundary.

C-34 to 60 inches; brown (10YR 4/3) extremely cobbly loam, pale brown (10YR 6/3) dry; massive; soft, friable, slightly sticky and slightly plastic; few fine medium and coarse roots; many fine and very fine tubular pores; 45 percent pebbles, 30 percent cobbles, 5 percent stones; very strongly acid.

The soil is generally moist, but in most years it is dry throughout the moisture control section for less than 45 consecutive days. The mean annual soil temperature ranges from 40 to 44 degrees F. The mean summer soil temperature is less than 47 degrees if the soil has an O horizon, or it is less than 59 degrees if the soil does not have an O horizon. Depth to bedrock is 60 inches or more. The fine earth fraction of the solum contains 20 to 60 percent ash or other pyroclastic material. Rock fragments in the 10- to 40-inch control section range from 35 to 80 percent. The solum ranges from 30 to 50 inches in thickness. The soil has an umbric epipedon 7 to 18 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 2 moist and 2 or 3 dry.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry. It has weak to moderate structure.

The C horizon is very stony loam to very cobbly loam.

Haploxerolls

Haploxerolls consist of deep to very deep, moderately well drained to well drained, steep soils on long narrow escarpments where the terraces meet the bottom lands and flood plains. These soils formed in a mixture of silt and sand and the accumulation of material that has creeped downslope. Slopes are short and are 20 to 50 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

A reference profile representing a Haploxeroll, steep, along the southeast edge of Mocks Bottom, NE1/4SW1/4SW1/4, sec. 16 T. 1 N., R. 1 E.

A11-0 to 5 inches; very dark gray (10YR 3/1) sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

A12-5 to 11 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; moderate, fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

B21-11 to 20 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine tubular pores; slightly acid; gradual wavy boundary.

B22-20 to 39 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; hard, firm, nonsticky and nonplastic; few fine and medium roots; many very fine tubular pores; slightly acid; gradual wavy boundary.

IIC1-39 to 49 inches; dark yellowish brown (10YR 4/4) loamy sand; massive; slightly hard, friable, nonsticky and nonplastic; few medium roots; many very fine tubular pores; 15 percent pebbles; slightly acid; gradual wavy boundary.

IIC2-49 to 60 inches; dark yellowish brown (10YR 4/4) gravelly sand; single grain; loose, nonsticky and nonplastic; few medium roots; many very fine irregular pores; 40 percent pebbles; slightly acid.

The soil is generally moist, but in most years it is dry to a depth of 4 to 12 inches for 45 to 75 consecutive days. The mean annual soil temperature ranges from 53 to 55 degrees F. The mollic epipedon is 10 to 25 inches thick. The soil is slightly acid in the surface layer and slightly acid to neutral in the subsoil.

The A horizon is fine sandy loam, sandy loam, loam, silt loam, or silty clay loam and has 0 to 50 percent coarse fragments.

The B horizon is sandy loam, loam, silt loam, or silty clay loam and has 0 to 65 percent coarse fragments.

Haplumbrepts

Haplumbrepts consist of moderately deep to very deep, moderately well drained to well drained soils in moderately steep to very steep mountainous areas and on side slopes of high terraces. These soils formed in colluvium from basalt and andesite mixed with loess, volcanic ash, and old alluvium. Slopes are 3 to 90 percent. The mean annual precipitation is about 70 inches, and the mean annual air temperature is about 51 degrees F.

A reference profile representing a Haplumbrept, moderately steep, along Gordon Creek Road, NE1/4NW1/4NE1/4 sec. 14, T. 1 S., R. 4 E.

A11-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 5 percent pebbles; medium acid; clear smooth boundary.

A12-9 to 14 inches; dark brown (10YR 3/3) loam, yellowish brown (10YR 5/4) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine irregular pores; 10 percent pebbles; medium acid; clear wavy boundary.

B21-14 to 26 inches; brown (10YR 4/3) cobbly loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine tubular pores; 10 percent pebbles, 20 percent cobbles; medium acid; gradual wavy boundary.

B22-26 to 36 inches; brown (10YR 4/3) gravelly clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common very fine and fine roots; many very fine tubular pores; 25 percent pebbles, 10 percent cobbles; medium acid; gradual wavy boundary.

B3-36 to 49 inches; dark yellowish brown (10YR 4/4) gravelly clay loam; light yellowish brown (10YR 6/4) dry; weak, medium subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; many very fine tubular pores; 5 percent cobbles, 25 percent pebbles; medium acid; gradual wavy boundary.

C-49 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly clay loam, light yellowish brown (10YR 6/4) dry; massive; few fine roots; many very fine tubular pores; 60 percent pebbles, 5 percent cobbles; medium acid.

The soil has a udic moisture regime but is dry to a depth of 4 to 12 inches for less than 45 consecutive days during a period of 4 months following the summer solstice. The mean annual soil temperature ranges from 51 to 53 degrees F. Depth to bedrock is 20 to 60 inches or more.

The A horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 1 to 3 moist or dry. This horizon is loam, silt loam, or silty clay loam and has 0 to 50 percent coarse fragments.

The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 or 4 moist or 6 dry, and chroma of 3 or 4 moist or dry. It has a few gray (10YR 5/1) and reddish brown (5YR 5/4) mottles on ped surfaces below a depth of 20 inches. This horizon is loam, silt loam, or silty clay loam and has 15 to 35 percent clay and 10 to 25 percent material coarser than very fine sand. It has 0 to 65 percent coarse fragments.

The C horizon has 0 to 65 percent coarse fragments.

Helvetia series

The Helvetia series consists of deep, moderately well drained soils on high terraces. These soils formed in old alluvium. Slopes are 3 to 30 percent. The mean annual precipitation is about 45.inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Helvetia silt loam, 2 to 8 percent slopes, 1 /4 mile east of the Germantown-Kaiser Road intersection, about 100 feet south of Germantown Road, NW1/4SW1/4SE1/4 sec. 8, T. 1 N., R. 1 W.

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

B1t-10 to 19 inches; dark yellowish brown (10YR 3/4) silty clay loam, brown (10YR 5/3) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many very fine tubular pores; few thin clay films; slightly acid; clear smooth boundary.

B21t-19 to 30 inches; dark yellowish brown (10YR 4/3) light silty clay, brown (10YR 5/3) dry; moderate coarse and medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; common moderately thick clay films on peds; medium acid; clear smooth boundary.

B22t-30 to 47 inches; dark yellowish brown (10YR 4/4) silty clay, pale brown (10YR 6/3) dry; few fine dark brown (10YR 3/3) concretions; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine tubular pores; many moderately thick clay films; few fine black manganese stains; medium acid; clear smooth boundary.

B2t-47 to 60 inches; dark yellowish brown (10YR 4/4) light silty clay, pale brown (10YR 6/3) dry; common fine faint gray (10YR 6/1), light gray (10YR 7/1),

and yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine tubular pores; few thin clay films on peds; medium acid.

The soil is generally moist, but in most years it is dry to a depth of 4 to 12 inches for 45 to 75 consecutive days. The mean annual soil temperature is 54 to 56 degrees F. Bedrock is at a depth of more than 60 inches. Faint mottles and black stains are below a depth of 30 inches in some pedons. Base saturation is less than 75 percent in all or in some part of the upper 30 inches of the pedon.

The A horizon is 10 to 14 inches thick. It has chroma of 2 or 3 moist or dry.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry and chroma of 2 or 3 dry. It has thin or moderately thick and common or continuous clay films on the horizontal and vertical surfaces of peds. This horizon is mainly silty clay and has 35 to 50 percent clay.

Kinzel series

The Kinzel series consists of deep, well drained soils in mountainous areas. These soils formed in colluvium from andesite and basalt mixed with glacial till and volcanic ash. Slopes are 5 to 90 percent. The mean annual precipitation is about 100 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Kinzel very gravelly silt loam, 50 feet north of road in NW1/4NW1/4 sec. 19, T. 1 S., R. 8 E.

O1-3 inches to 0; needles, twigs, cones, and leaves.

A11-0 to 7 inches; dark brown (7.5YR 3/2) very gravelly silt loam, dark brown (10YR 4/3) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; 30 percent pebbles, 15 percent cobbles, 2 percent stones; very strongly acid; gradual smooth boundary.

A12-7 to 13 inches; dark brown (7.5YR 3/3) very gravelly silt loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 30 percent pebbles, 15 percent cobbles, 2 percent stones; strongly acid; gradual smooth boundary.

B2-13 to 38 inches; dark brown (7.5YR 4/4) extremely cobbly silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 40 percent pebbles, 30 percent cobbles, 2 percent stones; medium acid; clear wavy boundary.

C-38 to 60 inches; brown (7.5YR 4/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; 50 percent pebbles, 25 percent cobbles, 5 percent stones; medium acid.

The soil is generally moist, but in most years it is dry to a depth of 8 to 24 inches for less than 45 consecutive days. The mean annual soil temperature ranges from 42 to 47 degrees F. Depth to bedrock or cemented till dominantly is more than 60 inches. Thickness of the solum ranges from 24 to 50 inches. The content of rock fragments ranges from 35 to 80 percent in the control section. Structure is weak to moderate in the solum.

The upper part of the A horizon has value of 2 or 3 moist and chroma of 1 or 2. The lower part of the A horizon has hue of 7.5YR and occasional variegations of 5YR, value of 2 or 3 moist, and chroma of 2 moist and 2 or 3 dry. The A horizon has 35 to 50 percent pebbles and 5 to 10 percent cobbles.

The B horizon has hue of 7.5YR or 10YR, value of 4 moist and 5 or 6 dry, and chroma of 3 or 4. It is silt loam, loam, or sandy loam and has 15 to 40 percent pebbles and 20 to 40 percent cobbles.

Compact, cemented glacial till is at a depth of 5 or 6 feet in some pedons.

Lastance series

The Lastance series consists of deep, well drained soils on broad ridges in steep mountainous areas. These soils formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. Slopes are 5 to 60 percent. The mean annual precipitation is about 120 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Lastance stony fine sandy loam, 50 feet south of the Bull Run River Road, 1 /4 mile west of the junction with the spur road to Bull Run Lake, SE1/4SW1/4 sec. 20, T. 1 S., R. 8 E.

O1-2 inches to 1 inch; needles, twigs, cones, and leaves.

O2-1 inch to 0; black (10YR 2/1) decomposed organic matter; many fine medium and coarse roots; extremely acid; abrupt wavy boundary.

A2-0 to 1 inch; gray (10YR 5/1) stony fine sandy loam, light gray (10YR 6/1) dry; massive; soft, very friable, nonsticky and slightly plastic; 20 percent pebbles, 5 percent cobbles, 5 percent stones; many fine medium and coarse roots; many fine and very fine irregular pores; extremely acid; abrupt wavy boundary.

B21ir-1 to 2 inches; dusky red (2.5YR 3/2) gravelly fine sandy loam, reddish brown (5YR 4/4) dry; massive; slightly hard, firm, nonsticky and slightly plastic; 20 percent pebbles, 5 percent cobbles, 5 percent stones; many fine medium and coarse roots; many fine and very fine irregular pores; strongly acid; abrupt wavy boundary.

B22ir-2 to 12 inches; dark brown (7.5YR 3/4) variegated with gray (10YR 5/1), dark brown (10YR 4/3), and brown (7.5YR 4/4) very cobbly fine sandy loam, brown (7.5YR 5/4) dry and crushed; weak fine and

very fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; 35 percent pebbles, 20 percent cobbles, 2 percent stones; many fine medium and coarse roots; many very fine and fine irregular pores; strongly acid; gradual wavy boundary.

C-12 to 60 inches; brown (7.5YR 4/4) extremely gravelly fine sandy loam, brown (10YR 5/4) dry and crushed; massive; soft, very friable, nonsticky and slightly plastic; 50 percent pebbles, 25 percent cobbles, 5 percent stones; common fine medium and coarse roots; many very fine and fine irregular pores; strongly acid.

The mean annual soil temperature ranges from 40 to 47 degrees F. The soil has a udic moisture regime but has a short dry period of less than 45 consecutive days during summer. Thickness of the solum ranges from 9 to 20 inches. The 10- to 40-inch control section is fine sandy loam and has less than 10 percent clay and 35 to 85 percent rock fragments. The soil is extremely acid or very strongly acid in the A2 horizon, very strongly acid to strongly acid in the B2 horizon, and strongly acid to medium acid in the B3 and C horizons. Stones cover as much as 0.1 percent of the surface.

The A2 horizon has value of 4 or 5 moist and 6 or 7 dry and chroma of 1 or less. It is loamy fine sand, fine sandy loam, or silt loam and has 20 to 30 percent pebbles and 5 to 10 percent cobbles.

The 132ir horizon has hue of 5YR or 2.5YR in the upper part and 7.5YR or 5YR in the lower part. It has value of 3 or 4 moist and 4 or 5 dry and chroma of 2 to 4 moist or dry. The upper part of the horizon is firm to very firm, and the lower part is friable to very friable. This horizon has 20 to 50 percent pebbles and 15 to 35 percent cobbles.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 or 4 moist or dry. It has 20 to 50 percent pebbles and 15 to 35 percent cobbles.

Latourell series

The Latourell series consists of very deep, well drained soils on broad terraces along the Columbia River and its tributaries. These soils formed in medium textured alluvium. Slopes are 0 to 30 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Latourell loam, about 1,000 feet east of road NW1/4SE1/4SW1/4 sec. 35, T. 1 N., R. 3 E.

Ap1-0 to 9 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; strong very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

Ap2-9 to 16 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak coarse platy structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

B21t-16 to 25 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; few, moderately thick clay films; medium acid; gradual wavy boundary.

B22t-25 to 37 inches; dark yellowish brown (10YR 4/4) heavy loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; common moderately thick clay films in pores and on peds; medium acid; gradual wavy boundary.

B3-37 to 45 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; few grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) streaks along root channels with gray (5YR 5/1) stains on the margins of the channels; weak fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few moderately thick clay films in pores; medium acid; gradual wavy boundary.

C1-45 to 56 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, sticky and plastic; many very fine tubular pores; few moderately thick clay films in pores; medium acid; abrupt wavy boundary.

IIC2-56 to 66 inches; dark yellowish brown (10YR 4/4) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, firm, nonsticky and nonplastic; many very fine tubular pores; slightly acid.

The mean annual soil temperature ranges from 54 to 56 degrees F. The soil is generally moist, but during summer it is dry to a depth of 4 to 12 inches for more than 60 consecutive days. Thickness of the solum ranges from 30 to 50 inches.

The A horizon has value of 3 or 4 moist and 5 or 6 dry and chroma of 3 or 4 moist or dry. It is loam to silt loam. The B horizon has value of 4 or 5 moist and 6 dry and chroma of 3 or 4 moist or dry. It has 18 to 22 percent clay. It has few to common and thin to moderately thick clay films.

The C horizon is 25 to 60 percent pebbles and has a few embedded stones or cobbles.

Mershon series

The Mershon series consists of very deep, moderately well drained soils on high terraces (fig. 26). These soils formed in old mixed alluvium. Slopes are 0 to 30 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 51 degrees F.

Figure 26.-Area of Mershon soils (0 to 30 percent slopes) on dissected high terraces.

Typical pedon of Mershon silt loam, 0 to 8 percent slopes, about 300 feet west of Little Page Road, SE1/4NE1/4NW1/4 sec. 2, T. 1 S., R. 4 E.

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine irregular pores; about 2 percent pebbles; medium acid; clear smooth boundary.

A12-8 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; about 2 percent pebbles; medium acid; clear wavy boundary.

B1-15 to 21 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; about 2 percent pebbles; medium acid; gradual wavy boundary.

B21-21 to 32 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few fine light brownish gray (10YR 6/2) mottles on peds; few firm nodules; about 2 percent pebbles; medium acid; clear wavy boundary.

B22-32 to 43 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few fine distinct gray (10YR

5/ 1) mottles on peds; about 2 percent pebbles; medium acid; clear wavy boundary.

B3-43 to 56 inches; dark brown (10YR 4/3) heavy silt loam, pale brown (10YR 6/3) dry; few fine distinct gray (10YR 5/1) mottles; moderate medium and fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few thin clay films in pores; few fine black stains; 10 percent pebbles, 5 percent cobbles; strongly acid; clear wavy boundary.

IIC-56 to 60 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; massive; very hard, very firm, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; common fine black stains; 10 percent partially weathered pebbles, 5 percent partially weathered cobbles; strongly acid.

The soil has a udic moisture regime, but it is dry to a depth of 4 to 12 inches for 45 consecutive days during a period of 4 months following the summer solstice. The mean annual soil temperature ranges from 51 to 53 degrees F. Depth to bedrock is more than 60 inches. Depth to the very firm IIC horizon ranges from 40 to 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. This horizon is loam or silt loam and has 0 to 10 percent pebbles:

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 6 dry, and chroma of 3 or 4 moist or dry. It has a few gray mottles on ped surfaces below a depth of 20 inches. This horizon is loam or silt loam and has 18 to 27 percent clay and less than 15 percent material coarser than very fine sand. It has 0 to 10 percent pebbles and 0 to 5 percent cobbles.

The IIC horizon has 0 to 10 percent pebbles and 0 to 5 percent cobbles.

Moag series

The Moag series consists of very deep, very poorly drained soils on broad undulating flood plains. These soils formed in recent clayey alluvium. Slopes are 0 to 2 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is 53 degrees F.

Typical pedon of Moag silty clay loam, protected, about 1,000 feet east of Oak Island Road, NW1/4SE1/4SE1/4 sec. 5, T. 2 N., R. 1 W.

Ap1-0 to 4 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; few fine prominent yellowish red (5YR 4/8) mottles; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

Ap2-4 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, light gray (10YR 7/2) dry; few fine prominent mottles; moderate medium subangular blocky structure; hard, firm, very sticky and plastic; few very fine roots; common very fine tubular pores; medium acid; abrupt smooth boundary.

B21-10 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine brown (7.5YR 5/3) dry mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, very sticky and plastic; few very fine roots; many very fine and fine tubular pores mostly vertical; medium acid; gradual wavy boundary.

B22-28 to 37 inches; dark gray (10YR 4/1) silty clay, light gray (2.5Y 7/2) dry; many fine distinct dark gray (10YR 4/1), yellowish brown (10YR 5/4), and yellowish red (5YR 4/8) mottles; strong moderate and coarse prismatic structure; very hard, very firm, sticky and very plastic; very few very fine roots; common very fine tubular pores; medium acid; abrupt smooth boundary.

C-37 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (10YR 7/1) dry; common dark gray (10YR 4/1) coatings in pores; many thick yellowish red (5YR 4/8) clay coatings in pores; massive; hard, firm, very sticky and plastic; medium acid.

The soil is saturated throughout the year. It is subject to freshwater overflow during high tides and to flooding in spring, unless diked and artificially drained. This soil is dry in places to a depth of 4 to 12 inches for short periods during summer. This soil has an ochric epipedon and does not have contrasting texture to a depth of 40 inches or more. Organic matter content decreases irregularly as depth increases. The mean annual soil temperature ranges from 53 to 55 degrees F.

The A horizon has value of 3 or 4 moist and 6 or 7 dry and chroma of 1 or 2 moist or dry. It has moderate to strong granular or subangular blocky structure.

The B horizon has value of 3 or 4 moist and 6 or 7 dry and chroma of 1 or 2 moist or dry. It has distinct or prominent mottles. This horizon is 40 to 50 percent clay. In some pedons, it has common thin lenses of peaty or loamy material that has value of 2 or 3 and chroma of 1.

The C horizon has hue of 10YR or 2.5Y or is neutral. It has value of 4 or 5 moist and chroma of 0 to 2 moist or dry. This horizon has distinct mottles and, in some areas, has dark brown (7.5YR 3/2) pipestems as much as 1 /4 inch in diameter in tubular pores and channels. In some pedons, it has common thin layers of gray (10YR 6/1) ashlike material.

Multnomah series

The Multnomah series consists of very deep, well drained soils on broad convex terraces. These soils formed in gravelly or cobbly alluvium (fig. 27). Slopes are 0 to 60 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Figure 27-Profile of Multnomah silt loam underlain by gravelly alluvium.

Typical profile of Multnomah silt loam, about 100 feet west of a shed, in southwest corner of SE1/4SE1/4SE1/4 sec. 7, T. 1 S., R. 3 E.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; moderate fine and very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; many fine and very fine concretions; 10 percent pebbles; medium acid; abrupt smooth boundary.

B21-8 to 16 inches; brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; weak fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine irregular pores; 15 percent pebbles; slightly acid; gradual wavy boundary.

B22-16 to 25 inches; brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; weak fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and coarse roots; many very fine irregular pores; 10 percent pebbles; slightly acid; clear wavy boundary.

C1-25 to 39 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few fine to coarse roots; many very fine irregular pores,; few thin clay films on bottoms of pebbles; 25 percent pebbles, 5 percent cobbles; medium acid; clear wavy boundary.

IIC2-39 to 60 inches; very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), and brown (10YR 4/3) very gravelly sand, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; single grain; loose, very friable, nonsticky and nonplastic; many very fine irregular pores; 45 percent pebbles, 10 percent cobbles; slightly acid.

The soil is generally moist, but during summer it is dry to a depth of 4 to 12 inches for more than 60 consecutive days. The mean annual soil temperature ranges from 54 to 56 degrees F. The thickness of the solum ranges from 20 to 30 inches, and the depth to contrasting texture ranges from 24 to 40 inches. The content of coarse fragments ranges from 0 to 25 percent in the A horizon, 15 to 35 percent in the B horizon, and 20 to 75 percent in the C horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. It is silt loam to gravelly silt loam and has 0 to 25 percent pebbles.

The B horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry, and chroma of 3 or 4 moist or dry. It is silt loam to gravelly loam and has 15 to 35 percent pebbles and 0 to 5 percent cobbles.

The IIC horizon is very gravelly or very cobbly loamy sand or very gravelly sand and has 35 to 75 percent pebbles and 0 to 20 percent cobbles.

Pilchuck series

The Pilchuck series consists of very deep, excessively drained soils on broad flood plains. These soils formed

in sandy alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Pilchuck sand, protected, north of Gillihan Loop Road, SW1/4NW1/4SE1/4 sec. 14 T. 2 N., R. 1 W.

Ap-0 to 12 inches; very dark grayish brown (10YR 3/2) sand, dark grayish brown (10YR 4/2) dry; weak fine and very fine granular structure; loose; many very fine roots; many very fine interstitial pores; neutral; clear smooth boundary.

C-12 to 60 inches; dark grayish brown (10YR 4/2) sand, grayish brown (10YR 5/2) dry; single grain; loose; few very fine roots; many very fine interstitial pores; neutral.

The soil is generally moist, but it is dry in most years to a depth of 4 to 12 inches for more than 45 consecutive days. The mean annual soil temperature ranges from 53 to 55 degrees F. Depth to bedrock is more than 60 inches. The control section commonly is sand or loamy sand. Coarse fragments range from none to 15 percent by weighted average. The soil is neutral to slightly acid.

The A. horizon has hue of 1 OYR or 2.5Y and chroma of 2 or 3 moist and 4 or 5 dry. It is mainly sand or loamy sand but ranges to fine sand.

The C horizon has hue of 10YR or 2.5Y, value of 2 to 4 moist and 3 to 6 dry, and chroma of 1 or 2 moist or dry. It is loamy sand, loamy fine sand, or medium sand.

Powell series

The Powell series consists of moderately deep, somewhat poorly drained soils on broad high terraces. These soils formed in silty materials. Slopes are 0 to 30 percent. The mean annual precipitation is about 55 inches, and the mean annual air temperature is 52 degrees F.

Typical pedon of Powell silt loam, 0 to 3 percent slopes, off Salquist Road, SW1/4SE1/4NW1/4 sec. 13, T. 1 S., R. 3 E.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; few fine firm peds or concretions; strongly acid; abrupt smooth boundary.

B21-8 to 13 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine firm peds or concretions; medium acid; clear smooth boundary.

B22-13 to 16 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; common fine distinct yellowish red (5YR 4/6) and few fine faint grayish brown (10YR 5/2) mottles; moderate fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine firm peds or concretions; strongly acid; abrupt wavy boundary.

Cx1-16 to 25 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) silt loam, pale brown (10YR 6/3) and light yellowish brown (10YR 6/4) dry; many medium distinct light brownish gray (10YR 6/2), grayish brown (10YR 5/2), and reddish brown (5YR 4/3) mottles; weak thin platy structure; hard, firm and brittle, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few fine and medium black stains; strongly acid; clear wavy boundary.

Cx2-25 to 39 inches; brown (10YR 4/3) silt loam, very pale brown (10YR 7/3) dry; many fine distinct yellowish red (5YR 5/6) mottles and light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) wedge-shaped silty coatings as much as 1 inch thick on vertical faces of prisms; weak medium and coarse prismatic structure; hard, firm, and brittle, slightly sticky and slightly plastic; few fine and common very fine tubular pores; few fine black stains; medium acid; clear wavy boundary.

Cx3-39 to 69 inches; variegated brown (10YR 5/3), yellowish brown (10YR 5/6), yellowish red (5YR 4/6), and pinkish gray (5YR 6/2) silt loam that has streaks in fractures of light brownish gray (10YR 6/2), light yellowish brown (10YR 6/4), and very pale brown (10YR 7/3); massive; hard, firm and brittle, slightly sticky and slightly plastic; many very fine and few medium tubular pores; few very fine black stains; slightly acid.

The soil is generally moist, but during summer it is dry throughout to a depth of 4 to 12 inches for more than 60 consecutive days. The mean annual soil temperature ranges from 52 to 56 degrees F. The depth to the fragipan ranges from 20 to 30 inches. Depth to bedrock is more than 60 inches. A perched water table develops over the fragipan during winter.

The A horizon has chroma of 2 or 3 moist.

The B horizon has less than 10 percent material that is coarser than very fine sand. It has hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 or 4 moist or dry.

The fragipan is 24 to 48 inches thick. It is silt loam that is firm or very firm and hard or very hard.

Quafeno series

The Quafeno series consists of very deep, moderately well drained soils on old terraces. These soils were formed in mixed, loamy alluvium. Slopes are 0 to 15 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Quafeno loam, about 100 feet north of railroad, SW1/4SE1/4SE1/4 sec. 20, T. 1 N., R. 3 E.

Ap1-0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine and fine irregular pores; slightly acid; clear smooth boundary.

Ap2-8 to 16 inches; very dark grayish brown (10YR 3/2) loam; brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine and fine tubular pores; slightly acid; abrupt smooth boundary.

B21-16 to 21 inches; dark yellowish brown (10YR 3/4) loam, pale brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common fine roots; many very fine and fine tubular pores; few fine black stains on peds; many concretions 1 to 2 millimeters in diameter; gradual wavy boundary.

B22-21 to 27 inches; dark brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine and fine tubular pores; few concretions 1 millimeter in diameter; slightly acid; gradual wavy boundary.

B3-27 to 36 inches; dark brown (10YR 4/3) very fine sandy loam, light yellowish brown (10YR 6/4) dry; few medium distinct grayish brown (10YR 5/2) and common fine faint strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few fine roots; many very fine tubular pores; slightly acid; gradual wavy boundary.

C1-36 to 65 inches; brown (10YR 4/3) very fine sandy loam, very pale brown (10YR 7/4) dry; few fine and common large distinct grayish brown (10YR 5/2) and common fine prominent strong brown (7.5YR 4/6) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few fine roots; many very fine tubular pores; slightly acid; abrupt wavy boundary.

IIC2r-65 to 70 inches; partially weathered sandstone.

The mean annual soil temperature ranges from 54 to 56 degrees F. The soil is generally moist, but during summer it is dry to a depth of 4 to 12 inches for 50 to 70 consecutive days. Depth to bedrock is 60 inches or more. Depth to mottles that have chroma of 2 or less ranges from 20 to 30 inches.

The A horizon has chroma of 2 or 3.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and chroma of 3 or 4 moist or dry. It is loam or very fine sandy loam. This horizon has an average 12 to 18 percent clay and has more than 15 percent material coarser than very fine sand.

The C horizon is fine sandy loam or very fine sandy loam.

Quatama series

The Quatama series consists of very deep, moderately well drained soils on old terraces. These soils were formed in mixed, loamy alluvium. Slopes are 0 to 30 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Quatama loam, about 100 yards northeast of Morgan Road, NE1 /4SE1 /4SE1 /4 sec. 12, T. 2 N., R. 2 W.

Ap-0 to 9 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate fine angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

B1-9 to 14 inches; dark yellowish brown (10YR 3/4) loam, pale brown (10YR 6/3) dry; moderate fine and very fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21t-14 to 24 inches; dark yellowish brown (10YR 4/4) light clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; few moderately thick clay films in pores; medium acid; clear smooth boundary.

B22t-24 to 33 inches; dark yellowish brown (10YR 4/4) clay loam, pale brown (10YR 6/3) dry; few fine dark grayish brown (10YR 4/2) and common medium reddish brown (5YR 4/3) mottles; moderate medium subangular blocky structure; hard, slightly brittle, slightly sticky and slightly plastic; few fine roots; common fine and medium pores; many medium clay films in pores and on ped faces; few fine black stains; medium acid; clear smooth boundary.

B3t-33 to 48 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; common fine distinct dark grayish brown (10YR 4/2) mottles; weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many very fine tubular pores; few thin clay films in pores and on ped faces; few fine black stains; medium acid; clear smooth boundary.

C1-48 to 56 inches; dark brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; common fine distinct dark grayish brown (10YR 4/2) mottles; massive; hard, firm and brittle, slightly sticky and slightly plastic; few thin clay films in pores; common black stains; medium acid; clear smooth boundary.

C2-56 to 60 inches; dark brown (10YR 4/3) sandy loam, yellowish brown (10YR 5/4) dry; common medium yellowish red (5YR 5/6) and grayish brown (10YR 5/2) mottles in vertical fractures; hard, friable,

nonsticky and nonplastic; few black stains on ped faces; medium acid.

The mean annual soil temperature ranges from 54 to 56 degrees F. The soil is generally moist, but during summer it is dry to a depth of 4 to 12 inches for 50 to 70 consecutive days. Depth to bedrock is 60 inches or more, and the thickness of the solum ranges from 40 to 60 inches. Depth to mottles that have chroma of 2 or less ranges from 15 to 30 inches. Stratified sandy loam to loamy sand is below a depth of 40 inches in some pedons.

The A horizon has chroma of 2 or 3.

The B2t horizon has value of 3 or 4 moist and chroma of 3 or 4. It has an average 27 to 35 percent clay and more than 15 percent material that is coarser than very fine sand. This horizon has moderately coarse to fine subangular blocky structure in the upper part and has weak, coarse or medium, subangular blocky structure in the lower part. It has thin to moderately thick clay films in channels and pores and on some vertical and horizontal faces of peds.

Rafton series

The Rafton series consists of very deep, very poorly drained soils on broad, undulating flood plains. These soils formed in recent silty alluvium. Slopes are 0 to 2 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Rafton silt loam, protected, about 90 feet north of drainage ditch, SW1/4NW1/4NE1/4 sec. 30, T. 3 N., R. 1 W.

Ap-0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; common fine prominent yellowish red (5YR 4/8 and 5/8) mottles; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

B2-9 to 21 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; many fine and medium prominent yellowish red (5YR 5/6 and 5/8) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores mostly vertical; thin brown coatings in pores; slightly acid; clear wavy boundary.

B3-21 to 40 inches; mottled brown (10YR 4/3) and gray (10YR 5/1) silt loam, gray (10YR 6/1), light gray (10YR 7/1 and 7/2), and reddish yellow (7.5YR 6/6) dry; many medium grayish brown (10YR 5/2) and common fine yellowish red (5YR 4/8) coatings in vertical pores; weak medium subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine and few medium tubular pores mostly vertical; slightly acid; clear wavy boundary.

C1-40 to 55 inches; dark grayish brown (10YR 4/2) silt loam, gray (10YR 6/2) dry; many medium and fine prominent reddish brown (5YR 4/4), yellowish red (5YR 4/8), and red (2.5YR 4/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; slightly acid; clear wavy boundary.

IIC2-55 to 60 inches; very dark gray (5Y 3/1) silt loam; common medium prominent yellowish red (5YR 4/8) and red (5YR 3/6) coatings in all pores; massive; hard, friable, nonsticky and slightly plastic; no roots; many medium tubular pores; slightly acid.

The soil is saturated throughout most of the year; however, it is dry in places to a depth of 4 to 12 inches for short periods in summer. It is subject to freshwater overflow during high tides and to flooding in spring, unless diked and artificially drained. The mean annual soil temperature ranges from 53 to 55 degrees F.

The A horizon has value of 4 or 5 moist and 6 or 7 dry and chroma of 1 or 2 moist or dry. It has moderate to strong granular or subangular blocky structure.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 moist and 6 or 7 dry, and chroma of 1 or 2 moist or dry. It has distinct or prominent mottles. In some pedons, this horizon has thin lenses of peaty or loamy material that have hue of 10YR, value of 2 or 3, and chroma of 1.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 moist, and chroma of 0 to 2. It is stratified silty clay loam to sandy loam. It has distinct to prominent mottles, and in some areas has dark brown (7.5YR 3/2) pipestems as much as 1 /4 inch in diameter in tubular pores and channels. In some pedons, this horizon has thin layers of gray (10YR 6/1) ashlike material.

Saum series

The Saum series consists of deep, well drained soils on ridgetops, steep canyon side slopes, and low hills (fig. 28). These soils formed in silty alluvium, colluvium, and residuum from basalt. Slopes are smooth and convex and are 8 to 60 percent. The mean annual precipitation is about 45 inches, and the mean annual temperature is about 52 degrees F.

The Saum soils in Multnomah County have an argillic horizon, but Saum soils in other areas do not. This argillic horizon, however, does not affect use and management of these soils.

Typical pedon of Saum silt loam, 8 to 15 percent slopes, 300 yards north of Rock Creek Road, NW1/4SW1/4SE1/4 sec. 36, T. 2 S., R. 2 W.

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

A11-0 to 5 inches; dark reddish brown (5YR 3/2) silt loam, reddish brown (5YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine irregular pores; 5 percent medium and

Figure 28.-Profile of Saum silt loam underlain by bedrock at a depth of 47 inches.

fine concretions; medium acid; abrupt smooth boundary.

A12-5 to 11 inches; dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 3/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine and fine tubular pores; 5 percent fine concretions; medium acid; clear smooth boundary.

B21-11 to 23 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 5/4) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; common fine roots; common fine and very fine tubular pores; 10 percent fine and medium basalt pebbles; medium acid; clear wavy boundary.

B22t-23 to 36 inches; reddish brown (5YR 4/4) silty clay loam, yellowish red (5YR 5/6) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; many fine and very fine tubular pores; common moderately thick clay films on peds and in pores; 10 percent pebbles; medium acid; clear wavy boundary.

C-36 to 50 inches; reddish brown (5YR 4/4) very gravelly silty clay loam, yellowish red (5YR 5/6) dry; massive; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; 50 percent fine basalt pebbles, 20 percent cobbles; medium acid; gradual wavy boundary.

Cr-50 inches; fractured basalt that has material from the C horizon in fractures.

The soil is generally moist, but in most years it is dry to a depth of 4 to 12 inches for more than 60 consecutive days. The mean annual soil temperature ranges from 53 to 56 degrees F. Depth to bedrock ranges from 40 to 60 inches. Occasional basalt boulders are in any part of some pedons. The A horizon has 3 to 5 percent pebbles. The B2 horizon has 0 to 10 percent pebbles and 0 to 5 percent cobbles. The IIB3 and IIC horizons have 15 to 30 percent pebbles, 5 to 20 percent cobbles, and 5 to 20 percent stones. Most of the pebbles, cobbles, and stones are unweathered or only partially weathered. In the control section rock fragments average 20 to 35 percent and clay ranges from 35 to 45 percent.

The A horizon has hue of 7.5YR or 5YR and chroma of 2 or 3 moist and 3 or 4 dry. This horizon is 10 to 15 inches thick.

The B2 horizon has value of 3 or 4 moist and chroma of 4 to 6 moist or dry. It is silty clay loam and has a clay content of 35 to 40 percent. Commonly, the lower part of this horizon has few to common, thin to moderately thick clay films.

The 11B3 and IIC horizons have color that is similar to the color of the B2 horizon, but these horizons range to silty clay and have a clay content of 35 to 50 percent.

Sauvie series

The Sauvie series consists of very deep, poorly drained soils on broad undulating flood plains. These soils formed in recent silty alluvium. Slopes are 0 to 2 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Sauvie silty clay loam, protected, about 1/4 mile west of Gillihan Loop Road, northwest corner SW1/4NW1/4 sec. 14, T. 2 N., R. 1 W.

Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine faint dark brown (10YR 3/3) mottles; strong fine subangular blocky structure; friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; few fine concretions; slightly acid; abrupt smooth boundary.

A12-9 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; many fine distinct dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm, slightly sticky, slightly plastic; common fine roots; many very fine pores; slightly acid; clear smooth boundary.

B21g-15 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam; many fine distinct dark brown (7.5YR 3/2) and dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm, slightly sticky, plastic; medium acid; abrupt smooth boundary.

B22g-18 to 27 inches; dark grayish brown (10YR 4/2) silty clay loam; many fine distinct gray (N 5/0) and dark brown (7.5YR 3/2) mottles; weak fine subangular blocky structure; firm, sticky, plastic; few fine roots; common fine pores; slightly acid; clear smooth boundary.

B3g-27 to 39 inches; dark grayish brown (10YR 4/2) silty clay loam; many fine and medium distinct gray (N 5/0) and dark brown (7.5YR 3/2) mottles; weak medium subangular blocky structure; firm, slightly sticky, slightly plastic; slightly acid; abrupt smooth boundary.

C-39 to 60 inches; dark grayish brown (10YR 4/2) very fine sandy loam; many fine and medium distinct dark brown (7.5YR 3/2), grayish brown (10YR 5/2), and gray (N 5/0) mottles; massive; friable, nonsticky, nonplastic; many very fine pores; slightly acid.

The soil is saturated from December through June. It is subject to freshwater overflow during high tides and to flooding in spring, unless diked and artificially drained. The mean annual soil temperature ranges from 53 to 55 degrees F. The soil is generally moist, but during summer it is dry throughout to a depth of 4 to 12 inches for about 45 to 60 consecutive days.

The A horizon is 10 to 24 inches thick and, in places, has distinct mottles in the lower part. It is silt loam and silty clay loam. A thin overwash of sand or fine sand less than 4 inches thick overlies the A horizon in some areas.

The B horizon has value of 3 or 4 moist. It has distinct to prominent mottles. It is 27 to 35 percent clay. In some pedons, this horizon has thin lenses of peaty or loamy material that has hue of 10YR, value of 2 or 3 moist, and chroma of 1 moist.

The C horizon has hue of 10YR or 2.5Y or is neutral, value of 4 or 5 moist, and chroma of 0 to 2. It is sandy loam to silt loam. This horizon has distinct or prominent mottles. In some areas, it has dark brown (7.5YR 3/2) pipestems as much as 1/4 inch in diameter in tubular pores and channels. In some pedons, this horizon has thin layers of gray (10YR 6/1) ashlike material.

Sifton series

The Sifton series consists of very deep, somewhat excessively drained soils on broad, undulating low terraces. These soils formed in gravelly alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Sifton gravelly loam, 0 to 3 percent slopes, about 100 feet east of road, NW1/4SW1/4SE1/4 sec. 8, T. 1 N., R. 1 W.

A11-0 to 8 inches; black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots; many very fine irregular pores; 20 percent pebbles, 5 percent cobbles; medium acid; clear smooth boundary.

A12-8 to 21 inches; very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine roots; many very fine tubular pores; 25 percent pebbles, 5 percent cobbles; medium acid; clear smooth boundary.

B2-21 to 30 inches; very dark brown (10YR 3/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine tubular pores; 30 percent pebbles; 10 percent cobbles; slightly acid; clear wavy boundary.

IIC-30 to 60 inches; dark brown (10YR 3/3) very gravelly loamy coarse sand, brown (10YR 4/3) dry; single grain; soft, very friable, nonsticky and nonplastic; many medium fine and very fine tubular pores; 50 percent pebbles, 10 percent cobbles; slightly acid.

The soil is generally moist, but in most years it is dry to a depth of 8 to 24 inches for 60 to 80 consecutive days. The mean annual soil temperature is 53 to 55 degrees F. Content of coarse fragments is 15 to 35

percent in the upper part of the control section and 50 to 75 percent in the lower part. The soil has hue of 10YR or 7.5YR.

The A horizon has value of 2 moist and 2 or 3 dry and chroma of 1 or 2. It has 10 to 25 percent pebbles and 0 to 5 percent cobbles. This horizon has weak granular or subangular blocky structure. It is very strongly acid to medium acid.

The B horizon has value of 3 or 4 moist and 4 or 5 dry and chroma of 3 or 4 moist or dry. It has 15 to 30 percent pebbles and 5 to 10 percent cobbles.

The IIC horizon has value of 3 or 4 moist and 4 to 6 dry and chroma of 2 to 4. It has 40 to 60 percent pebbles and 10 to 15 percent cobbles.

Talapus series

The Talapus series consist of deep, well drained soils in mountainous areas. These soils formed in colluvium mixed with glacial till and volcanic ash. Slopes are 5 to 60 percent. The mean annual precipitation is about 100 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Talapus very gravelly silt loam on Mt. Talapus, SW1/4NE1/4SW1/4 sec. 20, T. 1 N., R. 7 E.

O1-3 inches to 0; needles, twigs, leaves, and cones. A11-0 to 3 inches; black (10YR 2/1) very gravelly silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine irregular pores; 30 percent pebbles, 10 percent cobbles; strongly acid; wavy boundary.

A12-3 to 13 inches; very dark brown (10YR 2/2) very gravelly silt loam, brown (10YR 5/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 45 percent pebbles, 10 percent cobbles; strongly acid; clear wavy boundary.

B21-13 to 18 inches; dark brown (7.5YR 3/2) very gravelly loam, brown (10YR 5/3) dry; moist moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 45 percent pebbles, 5 percent cobbles; strongly acid; clear wavy boundary.

B22-18 to 23 inches; dark brown (7.5YR 3/3) extremely gravelly loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 70 percent pebbles, 10 percent cobbles; strongly acid; gradual wavy boundary.

B3-23 to 32 inches; brown (7.5YR 4/4) extremely gravelly loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; 70 percent pebbles, 10 percent cobbles; strongly acid; gradual wavy boundary.

C-32 to 60 inches; dark reddish brown (5YR 3/4) extremely gravelly loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; 70 percent pebbles, 10 percent cobbles; strongly acid.

The soil is generally moist, but during summer it is dry to a depth of 8 to 24 inches for less than 45 consecutive days. The mean annual soil temperature ranges from 40 to 47 degrees F. Depth to bedrock is more than 60 inches. The depth to glacial till ranges from 40 to 60 inches. The content of rock fragments ranges from 35 to 80 percent in the control section.

The A horizon has hue of 10YR or 7.5YR, value of 2 moist and 3 or 4 dry, and chroma of 1 or 2 moist and 1 to 3 dry. It is very gravelly loam or very gravelly silt loam and has 30 to 45 percent pebbles and 5 to 15 percent cobbles.

The B2 horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 3 or 4 moist or dry. This horizon is extremely gravelly loam to extremely gravelly silt loam. It has 10 to 18 percent clay, 55 to 70 percent pebbles, and 5 to 15 percent cobbles.

The IIC horizon is weakly cemented or strongly cemented. It is extremely gravelly and has 55 to 70 percent pebbles and 5 to 15 percent cobbles.

Wahkeena series

The Wahkeena series consists of deep, well drained soils in mountainous areas. These soils formed in colluvium from basalt and andesite. Slopes are 60 to 90 percent. The mean annual precipitation is about 70 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Wahkeena very cobbly clay loam, 200 feet west of the footbridge over Wahkeena Falls along the Wahkeena Trail, NE1/4NE1/4 sec. 13, T. 1 N., R. 5 E.

O1-1/2 inch to 0; loose litter of needles, leaves, twigs, and cones.

A1-0 to 5 inches; very dark brown (10YR 2/2) very cobbly clay loam, very dark grayish brown (10YR 3/2) crushed, and dark grayish brown (10YR 4/2) dry; strong very fine subangular blocky structure and very fine and fine granular; slightly hard, friable, sticky and plastic; many roots; many fine and very irregular and tubular pores; 20 percent pebbles, 20 percent cobbles; slightly acid; clear, wavy boundary.

B1-5 to 14 inches; dark brown (10YR 3/3) extremely cobbly clay loam, brown (10YR 4/3) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, sticky and plastic; many roots; many

fine and very fine irregular and tubular pores; 30 percent pebbles, 30 percent cobbles; neutral; clear wavy boundary.

B2-14 to 27 inches; dark brown (10YR 3/3) extremely cobbly clay loam, brown (10YR 4/3) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, sticky and plastic; common roots; many fine very fine medium and coarse irregular and many very fine tubular pores; 35 percent pebbles, 40 percent cobbles, 5 percent stones; neutral; clear wavy boundary.

B3-27 to 60 inches; dark brown (10YR 3/3) extremely cobbly clay loam, brown (10YR 4/3) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, sticky and plastic; common roots; many fine and very fine, few coarse irregular, and many very fine tubular pores; 35 percent pebbles, 40 percent cobbles, 5 percent stones; some very dark brown (10YR 2/2) lenses in the upper part; neutral.

The soil is generally moist, but during summer it is dry to a depth of 4 to 12 inches for less than 45 consecutive days. The mean annual soil temperature ranges from 50 to 56 degrees F. Solum thickness ranges from 24 to 60 inches. Depth to basaltic bedrock dominantly is more than 60 inches. All horizons range from clay loam to heavy loam, and the content of angular rock fragments ranges from 60 to 90 percent. Many interstices larger than 1 millimeter are not filled. Stone lines, consisting of angular pebbles, cobbles, and stones with little or no fines, are frequent within these soils. Base saturation is more than 50 percent throughout the profile. The mollic epipedon is 20 to 40 inches or more in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist, and chroma of 1 or 2 moist. It has 15 to 30 percent pebbles and 15 to 30 percent cobbles.

The B and C horizons have hue of 10YR or 7.5YR, value of 3 or 4 moist, and chroma of 3 or 4 moist. These horizons have 35 to 45 percent cobbles, 20 to 35 percent pebbles, and 5 to 10 percent stones.

Wapato series

The Wapato series consists of very deep, poorly drained soils on flood plains. These soils formed in recent alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

The Wapato soils in Multnomah County are taxadjuncts to the Wapato series because the control section of these soils has less than 27 percent clay.

Typical pedon of Wapato silt loam, along Beaver Creek, about 1/4 mile north of the intersection of Division and Troutdale Roads, SW1/4NE1/4NW1/4 sec. 12, T. 1 S., R. 4 E.

A1-0 to 12 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; few fine distinct dark yellowish brown (10YR 4/4) and yellowish red (5YR 4/8) mottles; moderate fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium and fine roots; many fine and very fine irregular pores; medium acid; clear smooth boundary.

B1-12 to 18 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; common medium prominent strong brown (7.5YR 4/6) and yellowish red (5YR 4/6) mottles; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and medium roots; many fine and very fine irregular pores; medium acid; clear smooth boundary.

B21-18 to 27 inches; grayish brown (10YR 5/2) heavy silt loam, light gray (10YR 7/2) dry; many fine prominent yellowish red (5YR 4/6 and 5/8) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

B22-27 to 35 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/1) dry; many fine prominent brown (7.5YR 4/4) and yellowish red (5YR 4/6) mottles; weak medium and coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; no roots; many very fine irregular pores; medium acid; clear smooth boundary.

B3-35 to 45 inches; grayish brown (2.5Y 5/2) silt loam, light gray (10YR 7/1) dry; few fine prominent yellowish red (5YR 4/6 and 5/8) mottles; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; no roots; many very fine irregular pores; medium acid; clear smooth boundary.

C-45 to 60 inches; dark greenish gray (5GY 4/1) and greenish gray (5GY 5/1) gravelly sandy clay loam, light greenish gray (5GY 7/1) dry; few fine prominent yellowish red (5YR 4/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; no roots; few very fine irregular pores; 40 to 60 percent pebbles; medium acid.

The soil has an aquic moisture regime, but for short periods during summer it is dry in places to a depth of 4 to 12 inches. The soil is subject to overflow from November to May. The average annual soil temperature ranges from 53 to 55 degrees F. Below a depth of 40 inches, content of coarse fragments ranges from 0 to 75 percent.

The A horizon has chroma of 1 to 3 moist. It has few, fine, faint to common, medium, prominent mottles.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 moist and 6 or 7 dry, and chroma of 1 or 2 moist or dry. It has few, fine, distinct to many, medium, prominent mottles. This horizon has 18 to 27 percent clay.

The C horizon has hue of 2.5Y or 5GY, value of 4 or 5 moist and 6 or 7 dry, and chroma of 0 to 1 moist or dry.

Wauld series

The Wauld series consists of moderately deep, well drained soils on north-facing side slopes on uplands. These soils formed in residuum and colluvium weathered from basalt. Slopes are 30 to 70 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Wauld very gravelly loam, 30 to 70 percent slopes, along the Wildwood Trail, NE1/4SW1/4SW1/4 sec. 13. T. 1 N., R. 1 W.

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

A1-0 to 6 inches; very dark brown (10YR 2/2) very gravelly loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine irregular pores; 50 percent pebbles; 10 percent cobbles; slightly acid; clear wavy boundary.

B1-6 to 14 inches; very dark grayish brown (10YR 3/2) extremely gravelly clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; many fine and very fine roots; many very fine tubular pores; 50 percent pebbles, 15 percent cobbles; slightly acid; clear wavy boundary.

B2-14 to 30 inches; dark brown (7.5YR 4/4) extremely gravelly clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many fine and very fine roots; many very fine tubular pores; 50 percent pebbles, 25 percent cobbles; slightly acid; abrupt irregular boundary.

IIR-30 inches; fractured basalt.

The mean annual soil temperature ranges from 52 to 54 degrees F. The soil is generally moist, but in places during summer it is dry to a depth of 4 to 12 inches for less than 45 consecutive days. Depth to bedrock ranges from 20 to 40 inches. The umbric epipedon is 20 to 30 inches thick. The control section is loam or clay loam and has 18 to 30 percent clay and 35 to 75 percent rock fragments.

The A horizon has value of 2 or 3 moist and 4 or 5 dry and chroma of 1 or 2 moist or dry. It has granular to subangular blocky structure. This horizon is very gravelly loam or very gravelly silt loam and has 20 to 50 percent pebbles, 10 to 15 percent cobbles, and 0 to 5 percent stones.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 2 to 4 moist or dry. It is very gravelly loam or very gravelly clay loam and has 25 to 50 percent pebbles, 10 to 25 percent cobbles, and 0 to 10 percent stones.

Wollent series

The Wollent series consists of very deep, poorly drained soils on terraces. These soils formed in old alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 55 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Wollent silt loam, about 500 yards northwest of the Multnomah Kennel Club, NW1/4NE1/4NW1 /4 sec. 34, T. 1 N., R. 3 E.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; few fine faint dark grayish brown (10YR 4/2) mottles; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

B1g-10 to 16 inches; gray (10YR 5/1) silt loam, light gray (10R 7/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; medium acid; clear smooth boundary.

B2-16 to 24 inches; gray (10YR 5/1) silt loam, light gray (10YR 7/1) dry; many fine and medium distinct and prominent brown (10YR 4/3) and reddish brown (5YR 4/4) mottles; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; 20 to 30 percent, 5 to 30 millimeters, firm and brittle, red and black concretions; medium acid; clear smooth boundary.

Cg-24 to 60 inches; gray (10YR 5/1) silty clay loam, light gray (10YR 7/1) dry; many fine and medium distinct and prominent brown (10YR 4/3) and reddish brown (5YR 4/4) mottles; massive; hard, friable, sticky and plastic; few very fine irregular pores; medium acid.

The mean annual soil temperature ranges from 52 to 54 degrees F. The soil has an aquic moisture regime, but in places it is dry for short periods during summer. A seasonal perched water table is on the surface or within a depth of 10 inches, and ponding is possible from November to May. The solum ranges from 20 to 36 inches in thickness. Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 moist and 4 or 5 dry and chroma of 1 to 2 moist or dry. This horizon has none or common, faint to distinct mottles.

The B horizon has value of 4 or 5 moist and 6 or 7 dry and chroma of 1 to 2 moist or dry. It is silt loam or silty clay loam and has distinct to prominent mottles.

The C horizon is commonly silty clay loam, but in places is stratified with sand or clay.

Zygore series

The Zygore series consists of deep, well drained soils in mountainous areas. These soils formed in colluvium. Slopes are 5 to 90 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Zygore gravelly loam, about 1/4 mile north of Larch Mountain Road, SE1/4SW1/4SE1/4 sec. 34, T. 1 N., R. 5 E.

O1-3 to 0 inches; needles, twigs, leaves, and cones.

A1-0 to 6 inches; dark brown (7.5YR 3/2) gravelly loam, dark brown (7.5YR 4/2) dry; moderate fine and very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine and medium roots; many very fine and fine irregular pores; 15 percent pebbles, 5 percent cobbles; 10 percent concretions 2 to 10 millimeters in diameter; medium acid; clear wavy boundary.

A3-6 to 10 inches; dark brown (7.5YR 3/2) gravelly loam, dark brown (7.5YR 4/3) 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; 15 percent pebbles, 5 percent cobbles; 10 percent concretions 2 to 10 millimeters in diameter; medium acid; clear wavy boundary.

B2-10 to 19 inches; dark brown (7.5YR 3/3) very cobbly loam, brown (7.5YR 4/4) dry; moderate fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 15 percent cobbles, 15 percent pebbles, 10 percent stones; 10 percent concretions 2 to 10 millimeters in diameter; medium acid; gradual wavy boundary.

B3-19 to 34 inches; dark brown (7.5YR 4/4) very cobbly 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; 25 percent cobbles, 15 percent pebbles, 5 percent stones; slightly acid; gradual wavy boundary.

C-34 to 60 inches; dark brown (7.5YR 4/4) extremely cobbly loam, brown (7.5YR 5/4) dry; massive; slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; 35 percent cobbles, 25 percent pebbles, 5 percent stones; slightly acid.

The estimated mean annual soil temperature is 43 to 47 degrees F. The soil is generally moist, but during summer it is dry to a depth of 4 to 12 inches for less than 45 consecutive days. The solum has hue of 10YR or 7.5YR. Depth to bedrock or highly fractured bedrock is more than 60 inches. The percentages of pebbles and cobbles range from 20 to 50 percent in the A horizon and from 35 to 70 percent in the B and C horizons; they increase as depth increases.

The A horizon has value of 2 or 3 moist and 4 or 5 dry and chroma of 2 or 3 moist or dry. It has granular or subangular blocky structure. This horizon is silt loam or loam and is gravelly or cobbly. It has 10 to 20 percent pebbles and 5 to 20 percent cobbles.

The B horizon has value of 3 or 4 moist and 4 or 5 dry and chroma of 3 or 4 moist. It is loam or silt loam, has less than 18 percent clay, and is cobbly or very cobbly. This horizon is 15 to 20 percent pebbles, 20 to 30 percent cobbles, and 0 to 5 percent stones.

The C horizon has value of 3 or 4 moist and 4 to 6 dry and chroma of 3 or 4 moist or dry. It has 15 to 30 percent pebbles, 20 to 40 percent cobbles, and 0 to 5 percent stones.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (32).

The 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 classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 25, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect 'the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol.* An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Fluvaquents (*Fluv*, meaning flood plain, plus *aquent*, the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Fluvaquents.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, mesic, Ultic Haploxeralfs.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Geomorphic surfaces and soil development

Dr. R. B. Parsons, research soil scientist, Soil Conservation Service, helped prepare this section.

Soil is a natural, three-dimensional body on the surface of the earth; it supports plants. The characteristics and properties of a soil are determined by physical and chemical processes resulting from the factors of climate, living organisms, time, topography, and parent material (7, 20, 23, 36). The influence of any one of these factors varies from place to place, but the interaction of all of them determines the kind of soil that forms.

Soil formation in Multnomah County has been greatly influenced by the very cold, wet, short growing season at a high elevation in the Cascade Mountains and by the warm, dry, long growing season at a low elevation along the Columbia River. The age and type of parent material have greatly influenced the kind of soil that formed in recent alluvium on flood plains along the Columbia River and in old alluvium on terraces. In the higher areas of eastern Multnomah County, colluvium and glacial till derived from andesite and basalt mixed with volcanic ash have imparted special characteristics to the soils.

In this section, climate and living organisms are discussed separately. The factors of time, topography, and parent material are grouped and discussed in "Geomorphic surfaces."

Climate

Climate has a strong influence on soil formation. Heat and moisture greatly influence the kind of vegetation and the productivity of vegetation. They influence the rate at which organic matter decomposes and minerals weather. Heat and moisture also influence the rate of removal of material from some soil horizons and the rate of accumulation in others.

In Multnomah County three major climatic areas greatly influence soil genesis: Areas that have a warm, dry summer and a cool, moist winter; areas that have a warm, moist summer and a cool, moist winter; and areas that have a cool, moist summer and a cold, moist winter. In the central part of the county, summer is warm and dry and the growing season is long. The winter is cool and moist. Plant growth begins early in spring and continues through midsummer. This has given rise to soils with a xeric moisture regime. On young surfaces, the accumulation of organic mater and limited leaching of bases have helped form Xerolls, such as Burlington, Helvetia, and Quafeno soils. In areas where the accumulation of organic mater has been slower or where man has removed part of the epipedon, Ochrepts such as Aloha, Multnomah, and Powell soils have formed. On older surfaces where soil-forming factors have been active for long periods of time, Xeralfs such as Quatama, Cornelius, and Latourell soils have formed. On the oldest surfaces Udults, such as the Cazadero soils, have formed.

In the lower foothills on the western and eastern sides of the county, summer is warm and moist and winter is cool and moist. The growing season is slightly shorter than in drier areas at a lower elevation. Plant growth begins late in spring and continues until late in summer or early in fall for soils that have a udic moisture regime. On younger surfaces, the accumulation of organic matter and rapid leaching of bases have helped form Andepts and Umbrepts, such as Aschoff, Bull Run, and Mershon soils. A fragipan is also evident in soils on the older surfaces, such as Goble and Cascade soils.

In the eastern part of Multnomah County on the foot slopes of the Cascade Mountains, summer is cool and moist and the growing season is short. The winter is cold and moist and has periods of snow cover. Plant growth and the kinds of plants in the climax community are limited. This area is within the Western Cascade physiographic province of Oregon (31). The area is in three plant zones (36) in which the soils have major differences. At an elevation between 1,700 to 2,800 feet, soils have formed under a native plant community within the western hemlock zone. This environment produces enough plant growth to form an umbric epipedon. Leaching has been such that base saturation is not excessively

low, and accumulations of aluminum, iron, and organic carbon are not present to form a spodic horizon. Frigid Umbrepts, such as Zygore soils, have formed.

At an elevation between 2,800 to 3,000 feet, the plant composition changes to a transition zone (fig. 29). In this zone less organic matter is produced at a lower elevation and this results in the formation of an ochric epipedon, such as in Divers soils.

At an elevation above 3,300 feet, the plant composition changes to noble fir (fig. 30). An umbric epipedon has formed and leaching has not produced albic and spodic horizons. Soils common to these areas are Cryumbrepts, which are represented by the Talapus soils.

In areas where annual precipitation exceeds 120 inches, eluviation within silicious materials has produced an albic horizon that has pH of 4.0. Spodic horizons with illuviated aluminum, iron, and organic carbon have formed. Soils common to these areas are Cryorthods, which are represented by Lastance soils.

which are represented by Lastance soils.

Figure 29.-Douglas-fir, western hemlock, big huckleberry, and beargrass on Kinzel-Divers-Goodlow association, moderately steep.

Living organisms

Living organisms, especially the higher plants, are active in soil formation. The changes they bring about depend mainly on the life processes peculiar to each kind of organism. The kinds of organisms that live on and in the soil are determined, in turn, by climate, parent material, topography or relief, and age of the soil.

Plants provide a cover that helps to reduce erosion and stabilize the soil surface. Leaves, twigs, roots, and remains of entire plants accumulate on the surface of forest soils and are decomposed by micro-organisms, earthworms, and other soil fauna. Plant roots widen cracks in the underlying rock, permitting water to penetrate. The uprooting of trees by wind also mixes soil layers and loosens the underlying material.

In Multnomah County, the soils formed under three major types of plant cover. In the xeric soil zone, grass was a prominent member of the plant community along with a mixed conifer and deciduous forest of Oregon white oak, bigleaf maple, and Douglas-fir. The annual dieback of roots provides large amounts of organic materials. The deciduous trees absorb calcium and other bases and return them to the soil annually, thus reducing the effects of leaching. Under these conditions Mollisols, such as Helvetia soils, have formed.

In the udic soil zone, the proportion of grasses and deciduous trees decreased and the proportion of conifers increased. Organic matter accumulated; however, bases were absorbed by the conifers but not so readily returned to the soil as in the xeric zone. The greater precipitation in the udic soil zone has resulted in more leaching of bases, so that soils that have an umbric epipedon, such as Mershon soils, have formed.

At a higher elevation, mainly in places in the Cascade Mountains where precipitation exceeds 120 inches annually, the plant communities are dominantly conifers such as western hemlock and noble fir. In these areas, the presence of large amounts of organic matter and the leaching of bases have produced a high hydrogen ion concentration and resulted in the formation of Typic Cryorthods, such as the Lastance soils.

Small animals, earthworms, insects, and micro-organisms influence the formation of soils in several ways. They mix organic matter into the mineral soil material and accelerate the decomposition of organic matter by breaking down the remains of plants. Small animals burrow into the soil and mix the layers. Earthworms and other small invertebrates feed on the organic matter in the upper few inches of soil material. They slowly but continually mix the soil material and can alter its chemistry. Bacteria, fungi, and other micro-organisms hasten the weathering of rocks and the decomposition of organic matter.

In Multnomah County conditions are generally favorable for most organisms to function. Earthworms are very common in all areas except the frigid and cryic soil zones. Small animals such as gophers and moles are

Figure 30.-Noble fir, rhododendron, big huckleberry, and beargrass on Lastance stony fine sandy loam, 5 to 30 percent slopes.

common in the lower, warmer areas and are very prominent in areas of Mershon and Bull Run soils. Man has played a prominent role in soil development by dredging sand from the Columbia River and depositing it on the adjacent flood plains. A large part of many areas of Pilchuck soils consist of dredged materials.

Geomorphic surfaces

Geomorphic surfaces were mapped on high-altitude aerial photographs of Multnomah County, see the Multnomah County geomorphology map at the back of this survey. The surfaces were visually traced throughout the survey area. Sequential relationship among surfaces, stereoscopic observations, and elevation, as well as photo interpretation of tonal patterns, were used to map the surfaces. Each geomorphic surface is named for a locality where that particular surface is well expressed (7, 22).

The geomorphic surfaces generally fit a time sequence, but exceptions are noted in the discussion of individual surfaces. A sequence of the surfaces in the order of their age is Horseshoe, Ingram, Luckiamute (some Horseshoe, Ingram, and Winkle surfaces), Winkle, Champoeg, Senecal, Bethel, Dolph, and Eola. The youngest surface, Horseshoe, is given the first position, and the oldest surface, Eola, is given the last position.

Also discussed but not considered a geomorphic surface is the Looney unit, which consists of steep, broken topography and some slopes that exceed 100 percent. Because of variable landscape stability, the soils and surfaces of the Looney unit fit no particular span of time.

Horseshoe surface. The Horseshoe surface is the lower of the two flood plains in the survey area. This surface has low relief and includes the stream channel and associated features, such as point bar deposits, channel fillings, and abandoned meanders. The Horseshoe surface is generally underlain by coarse or moderately coarse alluvium. Many areas have no plant cover, or they support only a young stand of willows or cottonwoods. Elevation is dominantly less than 20 feet. Annual flooding inundates this surface. Rapid changes in the

landscape result from cutting of new channels, abandonment of older channels, lateral migration of meanders, and downstream movement of alluvial deposits. In some third-order valleys, two flood plains (the Horseshoe and Ingram) are not identifiable. This is because of the recent age of the surface. The Horseshoe surface began to form only a short time ago, as shown by the presence of metallic artifacts in the alluvium. Therefore, a post-settlement age, since the middle of the 19th century, is reasonable.

Soils of the Horseshoe surface are typified by Xeropsamments and Fluvaquents; for example, the Pilchuck and Rafton soils, respectively. Pilchuck soils, which formed on dynamic surfaces such as flood plains, show little evidence of soil formation in an unweathered sandy sediment. Rafton soils have some darkening by organic matter in the A horizon and weak subangular blocky structure in the B horizon. These soils are so young that they have no diagnostic horizons other than an ochric epipedon. Also, Moag soils are on the Horseshoe surface.

Ingram surface. The Ingram surface is the higher of the two flood plains in the survey area. The topography of the Ingram surface is typically undulating, and as much as 10 feet of relief is produced by overbank channeling during flood stage (22). The bars and channels have an approximate orientation parallel to the stream. The expression of microrelief on the surface is related to the competence of the stream that flowed through the area. Longitudinal stream profiles with segmented gradients also add to the complexity of the Ingram surface as a flood plain. Elevations are generally between 20 and 50 feet. Texture is generally gravelly loam, silt loam, or silty clay loam, although some sandy strata are common.

Radiocarbon dating shows that the Ingram surface ranges from 550 to 3,290 years before the present. Therefore, the change in the stream system that caused abandonment of the Winkle surface as a flood plain occurred between 3,290 and 5,250 years ago (7), as the latter date is the minimum for the Winkle surface.

The partial abandonment of the Ingram surface as a flood plain occurred less than 550 years ago, which indicates the dynamic nature of the landscape.

Soils that formed in the alluvial sediment of the Ingram surface include Fluventic Haplaquolls and Typic Udipsamments. Sauvie, Faloma, and Wapato soils represent the first group and Dabney soils the latter. Sauvie, Faloma, and Wapato soils have a mollic epipedon, presumably inherited from the alluvial parent material, that has an irregular decrease in organic matter content as depth increases. These soils have weak to strong structure and have been in place long enough to exhibit the evidence of gleying and the mobility of ferrous iron to form distinct mottles. The Dabney soils show little development other than an accumulation of organic matter in the surface layer. Among the soils that are on this surface are the Wollent soils.

Luckiamute surface. This surface is on flood plains of small drainageways. It contains local alluvium derived from material on Bethel, Dolph, and Eola surfaces and the Looney unit. As defined, the concept of the Luckiamute surface includes areas of Horseshoe, Ingram, and in places, Winkle surfaces; areas of the included surfaces are so small, however, that to separate them in mapping is not practical.

The topography of the Luckiamute surface is typical of that of flood plains of small streams. Relief is absent except for minor corrugations by channeling. A few small alluvial fans that extend out of small valleys are included with the Luckiamute surface and contain sediment of variable composition, depending upon the source material that was eroded in the immediate area. Because the Luckiamute surface can be directly traced to the Horseshoe and Ingram surfaces, the age of the Luckiamute surface is assumed to relate to the age of the other two surfaces in the larger valleys. In the vicinity of Civic Stadium, the Luckiamute surface in places reflects the structural geology of the Portland fault. It represents a fault-line graben, as the surface is inset below the Champoeg surface after it emerges from Johnson Creek. The surface is not graded to other Holocene surfaces, but has a fan configuration likely produced by the collapse of the sediment under the Champoeg surface along the fault zone paralleling the Portland Hills.

The soils of the Luckiamute surface are discussed along with descriptions of the Horseshoe and Ingram surfaces.

Winkle surface. The Winkle surface is middle to early Holocene. It is the oldest surface related to the present drainage systems of the western part of Oregon. Most of this surface has morphology typical of abandoned flood plains of aggrading streams. The bars and channels along the Columbia River exhibit considerably greater relief than those along the Willamette River and its major tributaries and, consequently, better express the Winkle surface in the survey area. The elevation difference between bar and channel is largely because of the competence of the stream. The braided, overloaded stream channel that deposited sediment associated with the Winkle surface reflects the size of the stream responsible for the formation of the bars and channels (22). Elevations of the Winkle surface in this area generally range from 50 to 100 feet. The sediment is dominated by silt and clay and is commonly underlain by stratified sand and gravel at a depth of 4 to 6 feet.

A few very small areas of the Winkle surface are old lakebeds and low-relief, abandoned channels filled with peat or muck (2>). Age of the sediment beneath the Winkle surface, determined by Carbon 14 methods, ranges from a minimum of 5,250 years before the present to a maximum 12,240 years before the present (7). The Winkle surface in some places in the Willamette Valley contains strata of volcanic ash from the eruption of Mt. Mazama (Crater Lake); however, no Mazama ash has been identified in Multnomah County, except in the alluvium of Sauvie Island.

The well drained Burlington and Sifton soils are typical of soils that formed in sediment associated with the Winkle surface. The terraces in which the Burlington soils formed have been stable long enough for the soils to develop a mollic epipedon. The organic matter in the profile has resulted from pedogenesis rather than from organic matter inherited from the alluvial parent material. The sandy nature of these soils has facilitated the leaching of bases to a base saturation of less than 75 percent since the early Holocene. Areas of Burlington soils have dunelike microrelief, which suggests that the parent materials were reworked by wind during the early stages of soil development.

The Sifton soils, Vitrandepts, have an umbric epipedon and contain pyroclastic material derived from the eruption of Mt. Mazama. Carbon 14 dates of the Winkle surface span the time of the Mazama eruption. Areas of Sifton soils are gravel bars on which ash, either as airfall or alluvium, fills the interstices between the pebbles. Among the other soils on the Winkle surface are the Quafeno soils.

Champoeg surface, The geomorphic episode that resulted in the construction of the Champoeg surface at the close of the Pleistocene severely modified remnants of the older surfaces. In the Willamette Valley, the Champoeg surface is a relatively minor surface consisting of small, pediment-like landforms graded to a base level that remained stable only for a short time (7).

In the Tualatin Valley and the Portland area, the geomorphic episode resulting in the Champoeg surface was important in the evolution of local landscapes. Field correlation relates the Champoeg surface to the Portland Sand and Gravel (25, 27). Deposits associated with the Champoeg surface consist of torrentially cross-bedded gravel and cobbles with inclusions of large boulders, several of which are 8 to 10 feet in diameter. Foreset beds dip to the south, indicating the source of the gravel was the Columbia River. The sediment was probably derived from the Missoula Flood (2, 6), as the times proposed for these catastrophic floods fit the geomorphic sequence and correspond to Carbon 14 dates locally obtained. The gravel is attributed to a catastrophic flood formed by emptying of Lake Missoula in Montana into the Columbia River drainage (34). Elevations of the Champoeg surface generally range from 100 to 200 feet.

The outwash during the Champoeg episode truncated older surfaces in its path as evidenced by the asymmetry of Rocky Butte, Mount Tabor, and the remnant ridge of the Dolph surface immediately south of Wood Village. With vestiges of older surfaces preserved in the lee of the outwash, the area between Gresham and the Sandy River was obviously buttressed from the catastrophic flood by Broughton Bluff, so that a remnant of the Senecal surface east of Gresham was protected from truncation. The sand facies is common as an eddy deposit in the lee of older surfaces.

In the survey area, Multnomah soils, Dystric Xerochrepts, have formed in materials underlying the Champoeg surface. Development of an ochric epipedon and a cambic horizon that has weak structure are the dominant evidence of soil development. The lithologic discontinuity at a depth of 39 inches and a thin solum over very gravelly sand substratum has facilitated the leaching of this soil to a base saturation of 24 to 39 percent in the solum. Soils in other areas on the Champoeg surface in northwest Oregon have an argillic horizon. However, clay eluviated in the Multnomah soil would easily be translocated through the underlying gravel and below profile depth. The clay coatings on the bottom of pebbles is evidence of some clay eluviation into the gravel.

Senecal surface. The Senecal surface in the Willamette Valley has been derived from minor incision and integration of drainage of the Calapooyia surface (22), which is the main valley floor. The stratigraphy of deposits associated with the Calapooyia and Senecal surfaces in the southern part of Willamette Valley is considered to be silty and clayey sediments of Willamette Sound (8, 11). In Multnomah County remnants of the Calapooyia surface are so small that to include them in mapping is not practical. The Senecal episode is preserved as a few terrace remnants along major streams deeply incised below the former late Pleistocene valley floor. Elevation generally ranges from 200 to 300 feet.

Typical soils of the Senecal surface are Latourell, Quatama, and Aloha. Latourell and Quatama soils are the youngest soils in the survey area to exhibit an argillic horizon. Although these soils are texturally similar to Multnomah soils, the profile is thick enough to retain eluviated clay and form a distinct illuvial horizon. Leaching has been adequate to maintain a base saturation between 35 and 75 percent. Hence, these soils are Ultic or Aquultic Haploxeralfs.

Aloha soils have a low slope gradient and a brittle, dense, weakly cemented pan. These soils are somewhat poorly drained and are in an Aquic subgroup. Even though Aloha soils are classified as Xerochrepts, they have a few thin clay films on peds and in pores. The moderately slow permeability of these soils, resulting from the weak fragipan and low relief, tends to inhibit the eluviation of clay to form an argillic horizon.

Bethel surface. The Bethel surface in Multnomah County is at an elevation between 300 and 500 feet. It (16) consists of subdued, rolling hills that have moderate relief and gentle slopes and generally grade to the Senecal surface. Summits of the wider hills are nearly level. The Bethel surface is mantled with Irish Bend (8, 16) silty and clayey sediment that onlaps from the lower late Pleistocene surfaces of the main valley floor. This surface contains most of the glacial erratic boulders ice-rafted into the Willamette Valley area (3). Alluvial toe slopes of valleyside alluvium, probably of Holocene age, also help to blend the Bethel surface with the next lower surface. The Bethel surface is considered to be late Pleistocene (16).

The underlying structure of fault-blocks and linear folds may have produced the initial step-sequence, along

the Tualatin Mountains anticline, with subsequent onlap of Pleistocene sediment. These blocks form the core upon which the Bethel and Dolph surfaces developed.

Helvetia and Powell soils, Ultic Argixerolls and Typic Fragiochrepts, respectively, are extensive on the Bethel surface. Helvetia soils have a mollic epipedon, moderate structure, and an argillic horizon. They have been stable long enough to be somewhat depleted of bases. Unlike other soils that formed in Irish Bend silt (8, 16), Helvetia soils do not have a pachic epipedon probably because of erosion of somewhat steeper slopes over a longer period of time.

Powell soils have an ochric epipedon, a cambic horizon, and a fragipan. Powell soils consist of two increments of silt separated by a weathering interval (35). These increments apparently correspond to the Greenback and Irish Bend Members of the Willamette Formation (8). The fragipan in Powell soils at a depth of 16 inches is in the position of an argillic horizon and could effectively restrict the illuviation of clay.

Dolph surface. The Dolph surface is the second oldest group of landforms in the survey area. Topography of the Dolph surface varies but is well above the general level of valley floors. This surface occurs as remnants of extensive flats that have been dissected to form rolling topography. Landforms consist of a complex group of terraces, pediments, and upland remnants. The shoulders of valleys that grade to the Luckiamute surface, which is equivalent to the Ingram surface except it is underlain by local alluvium, are included in the Dolph surface. However, the backslopes, foot slopes, and alluvial toe slopes of small tributary valleys are included in the Luckiamute surface and its local alluvium.

The Dolph surface is underlain by bedrock, weathered gravel, saprolite, or clay deposits. The weathered loamy gravel under the Dolph surface in the survey area is derived from the Troutdale Formation; whereas, in the Willamette Valley the deposits are the Lacomb and Leffler Gravels. The Dolph surface is considered to be middle Pleistocene (7) because of its position in the landscape and the degree of weathering of underlying materials. Elevation commonly ranges from 450 to 600 feet. Remnants of the Dolph surface on the south and west flanks of Rocky Butte and Mount Tabor, Plio-Pleistocene volcanoes (1), were protected from late Pleistocene glacial outwash by these cinder cones.

The Cornelius soils, Ultic Haploxeralfs that have a fragipan, are representative of the Dolph surface in Multnomah County. The Cornelius soils have had some depletion of bases and have an argillic horizon above the fragipan as well as clay films in the fragipan. The greater thickness of the solum over the fragipan in Cornelius soils, as contrasted to Powell soils, provides material above the pan into which clay can be illuviated. Cornelius soils have had enough time for the profile to develop strong horizonation.

Eola surface. The Eola surface consists of erosional remnants of the oldest stable geomorphic surface in the survey area. The crests and upper parts of Powell Butte, Mount Scott, and the Tualatin Mountains are representative of Eola. Typical remnants are rounded hills and valleys, and hanging valleys are common. Relief of the Eola surface is moderate; it ranges to as much as 150 feet within the unit. Slopes range from 2 to 20 percent, and elevation generally exceeds 600 feet.

The Eola surface is considered early Pleistocene and was undoubtedly quite extensive. However, late Pleistocene and Holocene erosion removed much of this surface, and only small remnants remain. Landforms of the Looney unit generally adjoin Eola and join it to younger, lower lying surfaces.

In Multnomah County, the Eola surface is commonly overlain by an enigmatic silt or loess (26, 35) that in some places contains erratic pebbles and cobbles. This surface has numerous major faults (25), and the mantle of silt possibly is upfaulted silty sediment that generally underlies the Calapooyia, Senecal, and Bethel surfaces (8, 16). Major faults with displacements of 1,000 feet or more have been reported (25). Thickness of the silty mantle ranges from 78 to 130 (26) inches on stable Eola summits and decreases to 0 thickness within as little as 4 air miles to the southwest. This material would be better called Upland Silt (25) or Portland Hills Silt, than loess. The Upland Silt contains 19 percent sand, 64 percent silt, and 17 percent clay (34). It overlies bedrock, saprolite, or a reddish paleosol, perhaps the Diamond Hill Paleosol (8), that may be the precursor of Cazadero and Saum soils.

The Eola surface in Multnomah County is typified by Cazadero, Saum, and Cascade soils. Cazadero soils are Ultisols and, hence, represent the most advanced stage of weathering and leaching of bases in the survey area. Studies of soils of the Eola surface have shown that deep, red soils that have a prominent argillic horizon are mainly on stable ridgetops and pediment remnants (19, 22).

Saum soils, Typic Xerumbrepts, are shallower than Cazadero soils, are eroded remnants on metastable slopes (19), and have 23 inches of their solum developed in pedisediment overlying the truncated remnant of a paleosol.

Cascade soils, Typic Fragiumbrepts, formed in the Upland Silt. They commonly overlie a buried paleosol. Soil-stratigraphic relationships indicate that the Cazadero soils and similar Ultisols are relict paleosols, probably equivalent to the Diamond Hill Paleosol (8). The Cascade soils may contain several discontinuities based on mineralogic and stratigraphic evidence and, in some places, have two fragipans superimposed with an angular unconformity (35). Cascade soils possibly are the higher elevation equivalents of Powell soils. Their development has been restricted by a relatively impermeable fragipan and by erosion on steep slopes, or in proximity to steep slopes.

Looney unit. The Looney unit has no particular age connotation and, therefore, is not considered a geomor-

phic surface (7). The topography is completely dissected and predominantly steeply sloping. Slope gradient exceeds 100 percent in places. The steep, broken topography may join any other two surfaces, or it may make up large areas of mountainous terrain so thoroughly dissected that a geomorphic surface is not recognized. Erosion is active in much of the Looney unit, and in some areas mass movement is evident. In some areas, however, occasional remnants of some older geomorphic surfaces are present.

The variability in age makes the Looney unit useful in mapping areas of mountainous terrain. The eastern part of Multnomah County in the Cascade Mountains is in the Looney unit. Soils on the Looney unit in this part of the county are Divers, Kinzel, Lastance, and Talapus soils. The characteristics of these soils are discussed in "Climate" and "Living organisms." The Looney unit can be divided into several smaller geomorphic units if the scale in mapping is large enough. Three significant gradient breaks are apparent and correspond to stable, metastable, and active slopes (19). Valley floors and small alluvial cones are Luckiamute inclusions in the Looney unit. Soils formed in glacial till and colluvium, derived from andesite and basalt, mixed with volcanic ash.

Soils representative of the Looney unit in the western part of Multnomah County are Wauld and Goble soils. Wauld soils, Typic Haplumbrepts, have an umbric epipedon and a cambic horizon, are moderately deep over bedrock, and have steep metastable slopes (19). A lithologic discontinuity at a depth of 30 inches is apparent by the lack of a B3&C horizon and an abrupt boundary between the solum and bedrock. Goble soils, Andic Fragiumbrepts, have an umbric epipedon and a cambic horizon that overlie an unconforming fragipan that has clay films. These soils formed in the Upland Silt that consists of several contrasting sediments (35). Goble soils genetically differ from Cascade soils by being more than 30 inches deep to the fragipan, by containing a significant amount of amorphous clay, and by having a considerably lower base saturation because of better internal drainage and a more effective soil moisture regime. Other soils on the Looney surface are Mershon, Bull Run, and Aschoff soils.

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Glossary

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

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

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

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

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.

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

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

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock. Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively *drained.*-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well *drained*.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically 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 continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

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 water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

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

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

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

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

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable ac-

cording to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; occasional that it occurs on an average of once or less in 2 years; and frequent that it occurs on an average of more than once in 2 years. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

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

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

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

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

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

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

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the Soil *Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.-An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

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

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

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.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil

bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-

Border.-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders. Basin.-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.-Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.-Water is sprayed over the soil surface through pipes or nozzles from a pressure system. *Subirrigation.*-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

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

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

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Light textured soil. Sand and loamy sand.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

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

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

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

Miscellaneous areas. Areas that have little or no natural soil and support little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

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

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, common, and many, size-fine, *medium, and* coarse; and contrast-faint, distinct, and *prominent. The* size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

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

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained

from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

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

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

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

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

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity Index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

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

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

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

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

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

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

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

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

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Saprolite (geology). Soft, earthy, clay-rich, thoroughly decomposed rock formed in place by chemical weathering of igneous and metamorphic rock. In soil science, saprolite is any unconsolidated residual ma-

terial underlying the soil and grading to hard bedrock below.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

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

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	Less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and granular. Structureless soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent.-A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian.-A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched.-A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.