Foreword

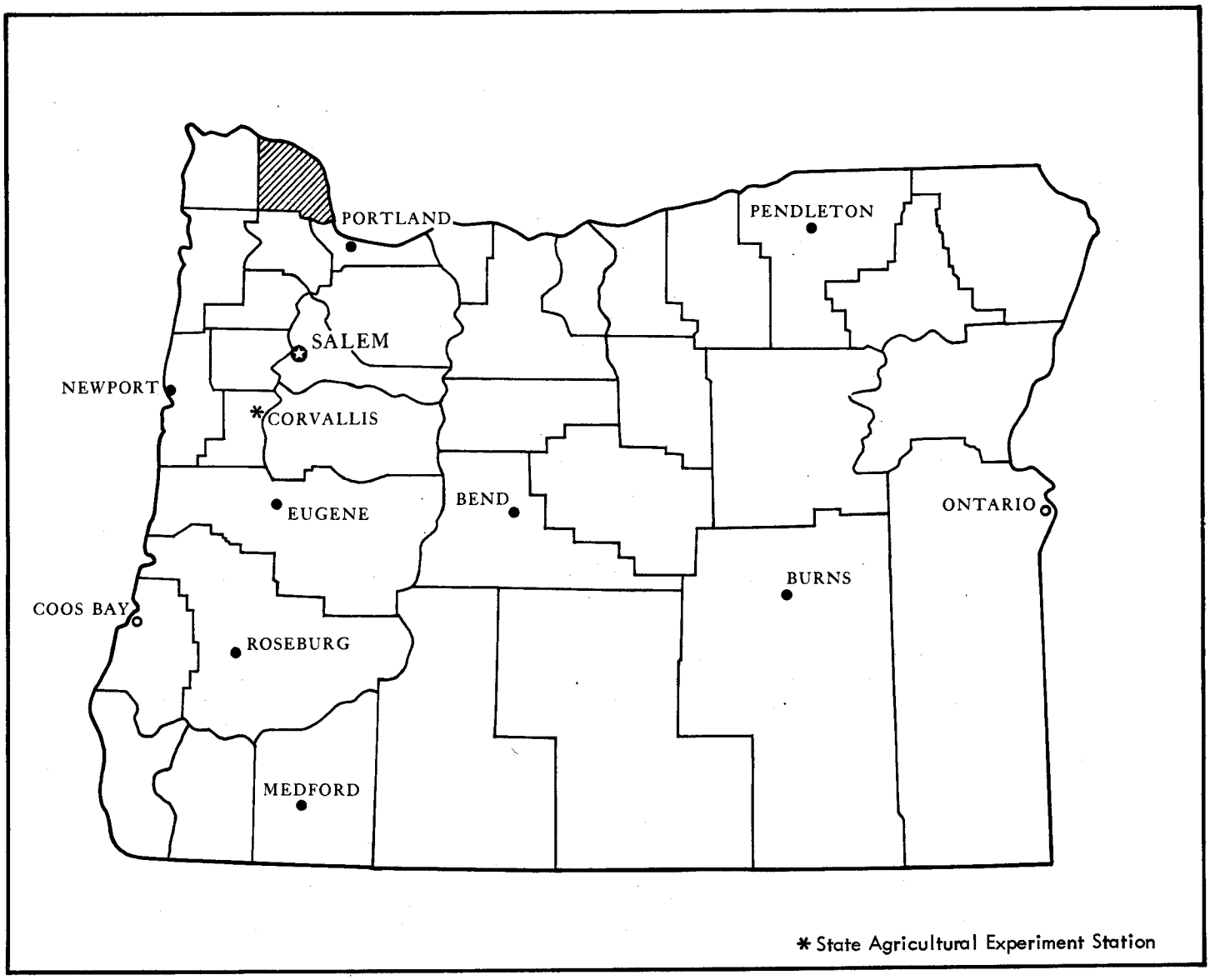
This soil survey contains information that can be used in land-planning programs in Columbia County, Oregon. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the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

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

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

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

Jack P. Kanalz
State Conservationist
Soil Conservation Service



Location of Columbia County in Oregon.

Soil Survey of
Columbia County, Oregon

By Richard T. Smythe, Soil Conservation Service

Fieldwork by George L. Green, Allen J. Gerig,
Russell W. Langridge, Richard F. Howard, and
Richard T. Smythe, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
In cooperation with
Oregon Agricultural Experiment Station

COLUMBIA COUNTY is in the northwestern part of Oregon. St. Helens, the county seat and the largest town, is in the eastern part of the county, along the Columbia River. The county is bounded by Clatsop, Multnomah, and Washington Counties. The Columbia River is the northern and eastern boundaries. The county extends west from the Columbia River and includes part of the Coast Range. The total area of the county is about 416,537 acres, or 651 square miles.

Columbia County has a well developed drainage system. The eastern part of the county is drained mainly by the Clatskanie River and Beaver, Tide, Milton, and Scappoose Creeks. The western part of the county is drained by the Nehalem River and its tributaries.

The northern and eastern parts of the county and the coastal valleys are on alluvial flood plains and terraces. Low foothills and mountainous areas merge in the western part of the county. The mountainous areas are mainly at an elevation of about 900 feet. Elevation in the county ranges from sea level on the flood plains to 2,240 feet on Buck Mountain.

The county has a modified marine climate. Annual precipitation ranges from 40 inches on the Columbia River flood plains and terraces to 100 inches in the Coast Range. As elevation increases, the temperatures and the length of the growing season decreases.

The rolling to very steep uplands in the Coast Range are forested and are managed primarily for timber. The flood plains, terraces, and low foothills and the major coastal valleys are used mainly for cultivated crops, including cereal grain, vegetables, berries and other fruit, nuts, and hay. Some areas are used for pasture.

An older survey, "Soil Survey of Columbia County, Oregon," was published in 1929 (20). This earlier survey covers a part of the present survey. The present survey, however, updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

Descriptions, names, and delineations of soils in this soil survey do not fully agree with those on soil maps for adjacent survey areas. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey.

General Nature of the Survey Area

General information about Columbia County is given in this section. Settlement and development, farming, and climate are briefly discussed.

Settlement and Development

By William Y. Eagle, district conservationist, Soil Conservation Service.

The first visitor to what is now Columbia County was probably in 1792, when Lt. William Broughton of the

British Royal Navy stepped ashore. During the next three decades many sailing ships entered the Columbia River to trade with the Indians. Lewis and Clark passed through the area in 1805 on their way to the Pacific Ocean.

A lumber mill was built in the county in 1844, and the town of St. Helens was established. It grew rapidly with the heavy influx of settlers in the early fifties. Columbia County was established on January 16, 1854, from part of Washington County. St. Helens became the permanent county seat in 1903. It flourished as a port for the Pacific Mail Lines.

During the late 1800's and early 1900's, the county's timber resources were exploited to the fullest. Roads were carved from the interior to ports along the Columbia River so that logs and lumber could be shipped to points south and east.

Prior to the 1930's, the county was almost entirely rural. Basic economic activity was centered around logging and agriculture. During World War 11, shipbuilding brought many people from other areas of the county, most of whom stayed after the shipbuilding ended.

Industrialization has accelerated in recent years, but dairying and horticulture remain important. Recreational pursuits are booming. A number of county and city parks and camping areas are in the county, and the Columbia River is used for boating and fishing. Two public golf courses are in the county.

The present population of the county is 35,900. The county is becoming a popular residential area for commuters to the Portland area.

Farming

Farming is an important industry in the county, ranking second only to the timber industry. It is the third largest employer in the county.

The county produces a wide variety of crops, including grain, berries, orchard crops, seed crops, pasture, hay, specialty crops, and woodland products.

The number of farms in the county and the acres farmed decreased steadily from 1959 to 1974; however, in 1978 there was an increase in the number of farms and in the number of acres farmed.

Climate

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Clatskanie, Oregon, in the period 1951-76. Table 2 shows probable dates of the last freeze in spring and the first freeze in fall. Table 3 provides data on length of the growing season.

In winter, the average temperature is 40 degrees F and the average daily minimum temperature is 35 degrees. The lowest temperature on record, which occurred at Clatskanie on December 8, 1972, is 5 degrees. In summer, the average temperature is 62 degrees and the average daily maximum temperature is 72 degrees. The highest recorded temperature, which occurred at Clatskanie on July 27, 1958, is 102 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 61 inches. Of this, 12 inches, or 20 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 7 inches. The heaviest 1-day rainfall during the period of record was 3.1 inches at Clatskanie on November 20, 1960. Thunderstorms occur on about 7 days each year, and most occur in summer.

The greatest snow depth at any one time during the period of record was 14 inches. On an average of 5 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 70 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 60 percent of the time in summer and 30 percent in winter. The prevailing wind is from the south-southwest. Average windspeed is highest, 9 miles per hour, in January.

How This Survey Was Made

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

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind or segment of the landscape. By observing the soils and miscellaneous areas in the survey area and relating their position to

specific segments of the landscape, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Individual soils on the landscape commonly merge gradually onto one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

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

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

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

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

General Soil Map Units

Allen J. Gerig, soil scientist, Soil Conservation Service, assisted in the preparation of this section.

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

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

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

The general map units in this survey have been grouped into general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

Map Unit Descriptions

Warm Soils on Flood Plains and Low Terraces

This group consists of two map units. It makes up about 9 percent of the survey area. The soils in this group are on flood plains and low terraces along the major rivers and streams throughout the county. The soils are characterized by moist summers.

1. Wauna-Locoda

Deep, nearly level poorly drained and very poorly drained silt loams that formed in recent alluvial deposits

This map unit is on broad, nearly level flood plains of the Columbia River (fig. 1). Most areas are protected from flooding by dikes; however, unprotected areas are subject to frequent flooding. The native vegetation is mainly Oregon ash, willow, black cottonwood, tussocks, and grasses. Elevation ranges from 0 to 20 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average annual frost-free period is 165 to 210 days.

This unit makes up about 4 percent of the survey area. Wauna and Locoda soils are the main components.

Wauna soils are deep and poorly drained. They are in the higher, slightly convex areas of flood plains. These

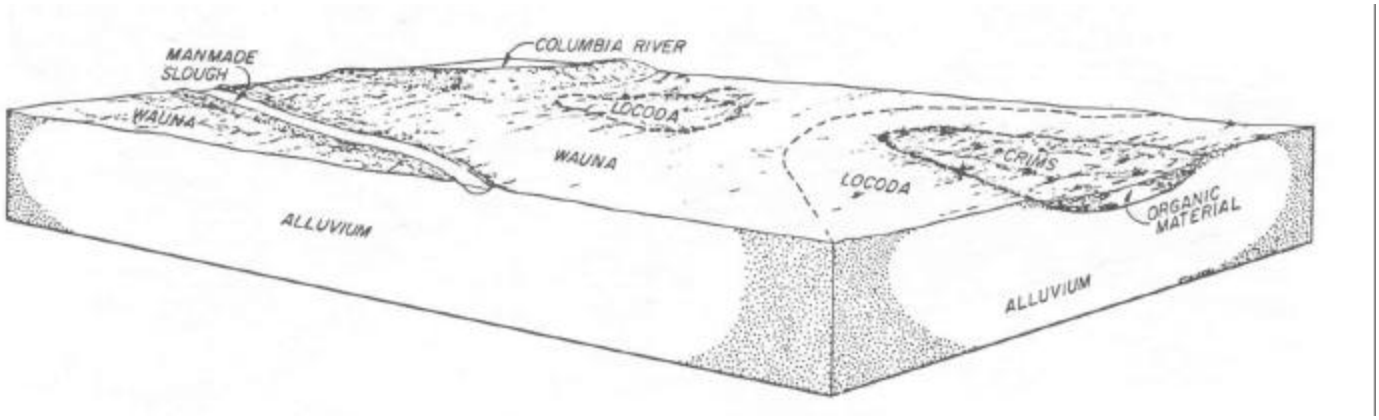


Figure 1.-Cross section of part of Columbia River flood plain showing relationship of soils, relief, and parent material in general soil map unit 1.

soils have a very dark gray silt loam surface layer and a mottled, dark grayish brown silt loam substratum.

Locoda soils are deep and very poorly drained. They are in the low, concave areas of flood plains. These soils have a mottled, dark grayish brown silt loam surface layer and a gray silt loam and silty clay loam substratum.

Of minor extent in this unit are the excessively drained, sandy Udipsamments on many of the islands of the Columbia River and along the riverbanks and the very poorly drained, organic Crims soils in backwater basins.

The protected areas of this unit are used primarily for hay and pasture. The main limitations are ponding and wetness. Use of proper stocking rates and restricted grazing during wet periods helps to maintain the pasture in good condition and to reduce soil compaction.

The unprotected areas of this unit are used mainly for wildlife habitat and for recreation, including hiking, picnicking, and hunting.

2. Eilertsen-Treharne-McNulty

Deep, nearly level, well drained and moderately well drained silt loams that formed in old and recent alluvial deposits

This map unit is on long, narrow flood plains and terraces of the Nehalem River and many other streams throughout much of the survey area (fig. 2). The areas of McNulty soils are subject to frequent flooding. The native vegetation is mainly Douglas-fir, western redcedar, western hemlock, red alder, bigleaf maple, red huckleberry, salal, and western swordfern. Elevation ranges from 20 to 800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 53 degrees F, and the average annual frost-free period is 110 to 180 days.

This unit makes up about 5 percent of the survey area. Eilertsen, Treharne, and McNulty soils are the main components.

Eilertsen soils are deep and well drained. They are on low terraces of most of the major streams in the area. These soils have a very dark brown silt loam surface layer and a dark brown and dark yellowish brown silty clay loam and silt loam subsoil.

Treharne soils are deep and moderately well drained. They are on low terraces of most of the major streams in the area. These soils have a very dark grayish brown silt loam surface layer and a mottled, brown silty clay loam subsoil.

McNulty soils are deep and well drained. They are on flood plains of major streams in the area. These soils have a very dark grayish brown silt loam surface layer, a dark brown silt loam subsoil, and a loam, silt loam, and sandy loam substratum.

Of minor extent in this unit are the poorly drained, clayey Natal soils in slightly concave areas on terraces and in abandoned stream channels and the well drained to moderately well drained Hapludalfs, Dystrochrepts, and Udifluvents on narrow terraces and flood plains of many of the streams in the area.

This unit is used mainly for hay and pasture. It is also used for timber production, homesite development, and wildlife habitat. Compaction can occur if the soils are

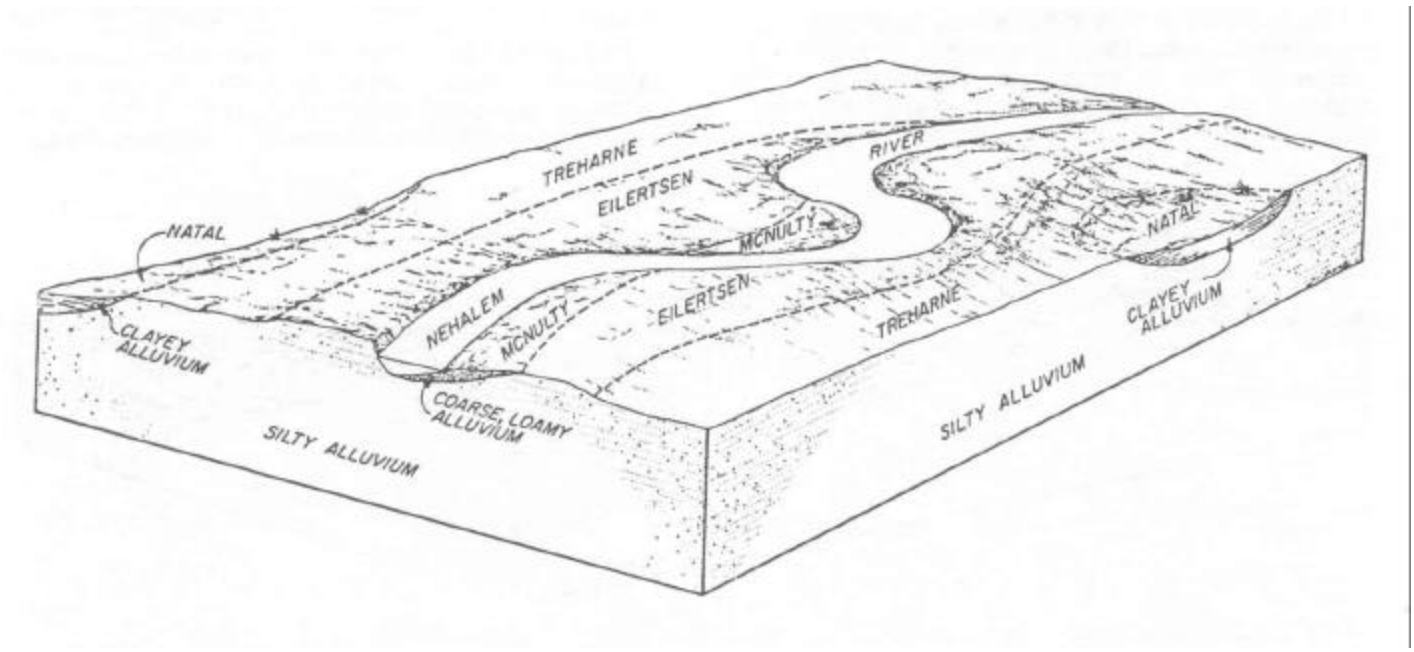


Figure 2.-Cross section of stream terraces showing relationship of soils, relief, and parent material in general soil map unit 2.

Figure 3.-Flooding in an area of Rafton soils that are not protected by dikes along the Columbia River.

grazed when wet. Grasses and legumes grow well if adequate fertilizer is used.

The McNulty soils are poorly suited to homesite development because of frequent flooding. The main limitations of the Treharne soils for use as homesites are a seasonal high water table and moderately slow permeability.

Warm Soils on Flood Plains

This group consists of one map unit. It makes up about 6 percent of the survey area. The soils in this group are on flood plains along the major rivers and streams throughout the county. The soils are characterized by dry summers.

3. Sauvie-Rafton

Deep, nearly level, poorly drained and very poorly drained silt loams and silty clay loams that formed in recent alluvial deposits

This map unit is on broad, nearly level flood plains of the Columbia River and on flood plains of Scappoose and Milton Creeks. Most areas are protected from flooding by dikes; however, the unprotected areas are subject to frequent flooding (fig. 3). The native vegetation is mainly Oregon white oak, black cottonwood, willow, common snowberry, tall Oregon-grape, sedges, and cattails. Elevation ranges from 10 to 20 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average annual frost-free period is 165 to 210 days.

This unit makes up about 6 percent of the survey area. Sauvie and Rafton soils are the main components.

Sauvie soils are deep and poorly drained. They are on high flood plains of the Columbia River. These soils have a very dark grayish brown silty clay loam surface layer and a mottled very dark gray silty clay loam and silt loam subsoil.

Rafton soils are deep and very poorly drained. They are on low flood plains of the Columbia River. These soils have a dark grayish brown silt loam surface layer and a mottled, grayish brown, brown, and gray silt loam subsoil.

Of minor extent in this unit are very poorly drained, clayey Moag soils in concave basins of flood plains of the Columbia River, excessively drained Sifton soils on Oak Island, and sandy Xeropsamments on many of the islands of the Columbia River and along the riverbanks. Also of minor extent are moderately well drained, loamy McBee soils; poorly drained, clayey Wapato soils; and well drained, loamy Cloquato soils along Scappoose Creek.

Where this unit is protected from flooding by dikes, it is used for hay, pasture, row crops, and berries. It is also used for wildlife habitat, homesite development, and recreation. The main limitation for crop production is wetness. Artificial drainage can be used to lower the water table if a suitable outlet is available. Compaction can occur if the soils are grazed when wet.

Where this unit is not protected from flooding by dikes, it is used mainly for wildlife habitat, recreation, and pasture. Recreational activities include hiking, picnicking, and hunting.

Warm Soils on Terraces and Low Hills

This group consists of four map units. It makes up about 8 percent of the survey area. The soils in this group are on terraces and low hills along the Columbia River. They are characterized by dry summers.

4. Quatama-Aloha

Deep, nearly level to moderately steep, moderately well drained and somewhat poorly drained silt loams that formed in old alluvial deposits

This map unit is on broad terraces of the Columbia River, dominantly between Scappoose and St. Helens. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, common snowberry, and tall Oregon-grape. Elevation ranges from 100 to 300 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average annual frost-free period is 165 to 210 days.

This unit makes up about 3 percent of the survey area. Quatama and Aloha soils are the main components.

Quatama soils are deep and moderately well drained. They are on slightly convex, broad, nearly level to moderately steep terraces. These soils have a dark brown silt loam surface layer and a mottled, dark yellowish brown silty clay loam and loam subsoil.

Aloha soils are deep somewhat poorly drained. They are on nearly level to gently sloping terraces. These soils have a dark brown silt loam surface layer and a mottled, dark brown and dark yellowish brown silt loam and loam subsoil.

Of minor extent in this unit are deep, moderately well drained, loamy Quafeno soils; deep, well drained, loamy Latourell soils; and deep, poorly drained, loamy Wollent soils and deep, poorly drained, clayey Dayton soils in concave areas of terraces.

This unit is used mainly for crop production. It is also used for homesite development, wildlife habitat, and recreation. The main limitation for crop production is a seasonal high water table in most areas. Tile drainage can be used to lower the water table if a suitable outlet is available.

5. Sifton-Multnomah

Deep, nearly level, somewhat excessively drained and well drained loams that formed in old gravelly alluvial deposits

This map unit is on low terraces of the Columbia River, near Scappoose and Columbia City. The native vegetation is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, common snowberry, tall Oregon-grape, and rose. Elevation ranges from 30 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 average annual frost-free period is 165 to 210 days:

This unit makes up about 1 percent of the survey area. Sifton and Multnomah soils are the main components.

Sifton soils are deep and somewhat excessively drained. They are on low terraces. These soils have a black loam surface layer and a dark brown extremely cobbly sand and extremely gravelly sand subsoil.

Multnomah soils are deep and well drained. They are on low terraces. These soils have a dark brown loam surface layer, a dark brown loam subsoil, and a dark brown very gravelly loam substratum.

Of minor extent in this unit are the deep, moderately well drained, loamy Quafeno soils and the deep, somewhat poorly drained, loamy Aloha soils.

This unit is used mainly for crop production. It is also used for homesite development, wildlife habitat, and recreation. The Multnomah soils are used for timber production. The main limitation of the unit for crop production is droughtiness. Irrigation is required for maximum production of most crops.

6. Rock outcrop-Xerumbrepts

Rock outcrop, and shallow, nearly level, well drained silt loams and loams that formed in alluvial deposits

This map unit is on a rock-floored terrace. The vegetation on Xerumbrepts is mainly Oregon white oak, poison-oak, and grasses. Elevation ranges from 50 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 average annual frost-free period is 165 to 210 days.

This unit makes up about 1 percent of the surrey area. It consists mainly of Rock outcrop and Xerumbrebts.

Rock outcrop consists of areas of exposed basalt.

Xerumbrebts are shallow, nearly level, well drained silt loams and loams. These soils are highly variable.

This unit is used mainly for homesite and urban development. It is limited mainly by the areas of Rock outcrop, which interfere with leveling and excavation.

Warm Soils that are on Terraces and Low Hills and have a Hardpan or Claypan

This group consists of three map units. It makes up about 23 percent of the survey area. The soils in this group are on low, rolling hills and terraces throughout the county. They are characterized by moist summers.

7. Cornelius-Cascade

Deep, gently sloping to moderately steep, moderately well drained and somewhat poorly drained silt loams that formed in silty material

This map unit consists of low, rolling hills adjacent to the terraces of the Columbia River, between Columbia City and the Multnomah County line. The native vegetation consists of Douglas-fir, western redcedar, western hemlock, bigleaf maple, Pacific dogwood, common snowberry, tall Oregon-grape, and salal. Elevation ranges from 300 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average annual frost-free period is 165 to 210 days.

This unit makes up about 3 percent of the survey area. Cornelius and Cascade soils are the main components.

Cornelius soils are deep and moderately well drained. They are on low, rolling hills. These soils have a dark brown silt loam surface layer and a brown silty clay loam subsoil over a mottled, brown silt loam hardpan.

Cascade soils are deep and somewhat poorly drained. They are on broad ridgetops of low, rolling hills. These soils have a dark brown silt loam surface layer and subsoil over a dark brown silty clay loam hardpan.

Of minor extent in this unit are the deep, poorly drained Delena soils in concave positions and Xerochrepts on steep slopes in areas that have been cut by streams.

This unit is used for crop production, timber production, homesite development, wildlife habitat, and recreation.

The main limitations for crop production are a seasonal perched water table and a high hazard of erosion in the steeper areas. Artificial drainage can be used to lower the water table.

Limited rooting depth and wetness are the main limitations of this unit for timber production. Compaction can occur if heavy equipment is used when the soil is wet.

The main limitations for homesite development are the seasonal perched water table and slow permeability. Slope is a limitation in the steeper areas.

8. Goble

Moderately deep, gently sloping to moderately steep, moderately well drained silt loams that formed in silty material

This map unit is on rolling hills adjacent to the Columbia River terraces in the eastern and northern parts of the survey area. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, cascade Oregon-grape, salal, and western swordfern. Elevation ranges from 300 to 1,000 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 47 to 50 degree F, and the average annual frost-free period is 100 to 180 days.

This unit makes up about 14 percent of the survey area. Goble soils are the main components.

Goble soils are moderately deep and moderately well drained. They are on convex, broad ridgetops and side slopes of rolling hills. These soils have a brown silt loam surface layer and subsoil over a mottled, dark yellowish brown silty clay loam hardpan.

Of minor extent in this unit are the poorly drained, loamy Delena soils in concave positions; the well drained, loamy, Bacona soils on stable uplands; the moderately deep, well drained Wauld soils on the steeper side slopes; and the deep, well drained, gravelly Multnomah Variant soils on terraces between the towns of Clatskanie and Mayger.

This unit is used for timber production, hay, pasture, wildlife habitat, and homesite development.

The main limitations for timber production are wetness and poor trafficability. Use of heavy equipment when the soil is wet can cause compaction.

Wetness and a short growing season are the main limitations for pasture and hay production. Grazing when the soil is wet can cause compaction.

The main limitations for homesite development are wetness and slow permeability. Slope is a limitation in the steeper areas of this unit.

9. Mayger-Glohm

Moderately deep and deep, gently sloping to moderately steep, moderately well drained and somewhat poorly drained silt loams that formed in colluvium derived from sedimentary rock

This map unit is on smooth, broad ridgetops of terraces and on side slopes of rolling hills. It is in the western half of the survey area, dominantly between Vernonia and Mist. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, red huckleberry, cascade Oregon-grape, and salal. Elevation ranges from 300 to 1,200 feet. The average

annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the average annual frost-free period is 100 to 180 days.

This unit makes up about 9 percent of the surrey area. Mayger and Glohm soils are the main components.

Mayger soils are deep and somewhat poorly drained. They are on smooth, broad ridgetops of terraces and side slopes of rolling hills. These soils have a very dark grayish brown silt loam surface layer and a mottled, dark yellowish brown silty clay loam subsoil over a mottled, grayish brown claypan.

Glohm soils are moderately deep and moderately well drained. They are on broad, convex, stable ridgetops of terraces and on side slopes of rolling hills. These soils have a dark brown silt loam surface layer and a brown silt loam and silty clay loam subsoil over a mottled, yellowish brown silty clay loam fragipan.

Of minor extent in this unit are the well drained, loamy Scaponia soils and the moderately deep, well drained, loamy Braun soils on the steeper side slopes; the well drained, silty Vernonia soils on stable uplands; and the poorly drained, clayey Kenusky soils in concave positions.

This unit is used mainly for timber production and wildlife habitat. The main limitations for timber production are wetness and poor trafficability. The Mayger soils are subject to landsliding and slumping if they are disturbed when harvesting timber.

Warm Soils on Mountains and Low Hills

This group consists of three map units. It makes up about 48 percent of the survey area. The soils in this group are on low hills and mountains throughout the county. They are characterized by moist summers.

10. Scaponia-Braun-Anunde

Deep and moderately deep, gently sloping to very steep, well drained silt loams that formed in colluvium derived from sedimentary rock

This map unit is on broad, stable ridgetops and side slopes of mountains, mainly along the western part of the survey area. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, bigleaf maple, red alder, vine maple, cascade Oregon-grape, salal, and western swordfern. Elevation ranges from 80 to 1,500 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 45 to 53 degrees F, and the average annual frost-free period is 100 to 210 days.

This unit makes up about 10 percent of the survey area. Scaponia, Braun, and Anunde soils are the main components.

Scaponia soils are deep and well drained. They are on steep, convex mountainsides. These soils have a dark brown silt loam surface layer and a dark yellowish brown silt loam subsoil.

Braun soils are moderately deep and well drained. They are on active, convex mountainsides. These soils have a dark brown silt loam surface layer and a dark yellowish brown silt loam subsoil.

Anunde soils are deep and well drained. They are on stable, convex, broad ridgetops of rolling low hills. These soils have a dark brown silt loam surface layer and a dark yellowish brown silt loam and silty clay loam subsoil.

Of minor extent in this unit are the well drained, loamy Tolke soils on stable ridgetops and side slopes and the well drained, very gravelly Alstony soils on ridgetops and the steeper side slopes.

This unit is used mainly for timber production and wildlife habitat. It is well suited to timber production. The main limitation is steepness of slope of the Scaponia and Braun soils. Using highlead or other logging systems that fully or partially suspend logs can reduce disturbance of the soil and erosion.

11. Bacona-Alstony

Deep, gently sloping to very steep, well drained silt loams and gravelly loams that formed in colluvium derived from sedimentary and igneous rock

This map unit is on broad ridgetops and side slopes of mountains (fig. 4). It is mainly in the central part of the survey area. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, bigleaf maple, vine maple, cascade Oregon-grape, salal, and western swordfern. Elevation ranges from 300 to 1,600 feet. The average annual precipitation is 50 to 75 inches, the average annual air temperature is 45 to 52 degrees F, and the average annual frost-free period is 100 to 180 days.

This map unit makes up about 23 percent of the survey area. Bacona and Alstony soils are the main components.

Bacona soils are deep and well drained. They are on stable, convex, broad ridgetops and side slopes of rolling mountains. These soils have a dark brown silt loam surface layer and a reddish brown silty clay loam subsoil.

Alstony soils are deep and well drained. They are on the steeper side slopes of mountains. These soils have a dark brown gravelly loam surface layer and a brown very gravelly loam subsoil.

Of minor extent in this unit are the well drained, loamy Dowde, Scaponia, and Braun soils on the steeper side slopes and the somewhat poorly drained, clayey Mayger soils and the poorly drained, clayey Kenusky soils in concave positions.

This unit is used mainly for timber production and wildlife habitat. The main limitations for timber production are poor trafficability on the Bacona soils and steepness of slope of the Alstony soils. Use of heavy equipment when the soils are wet can cause compaction.

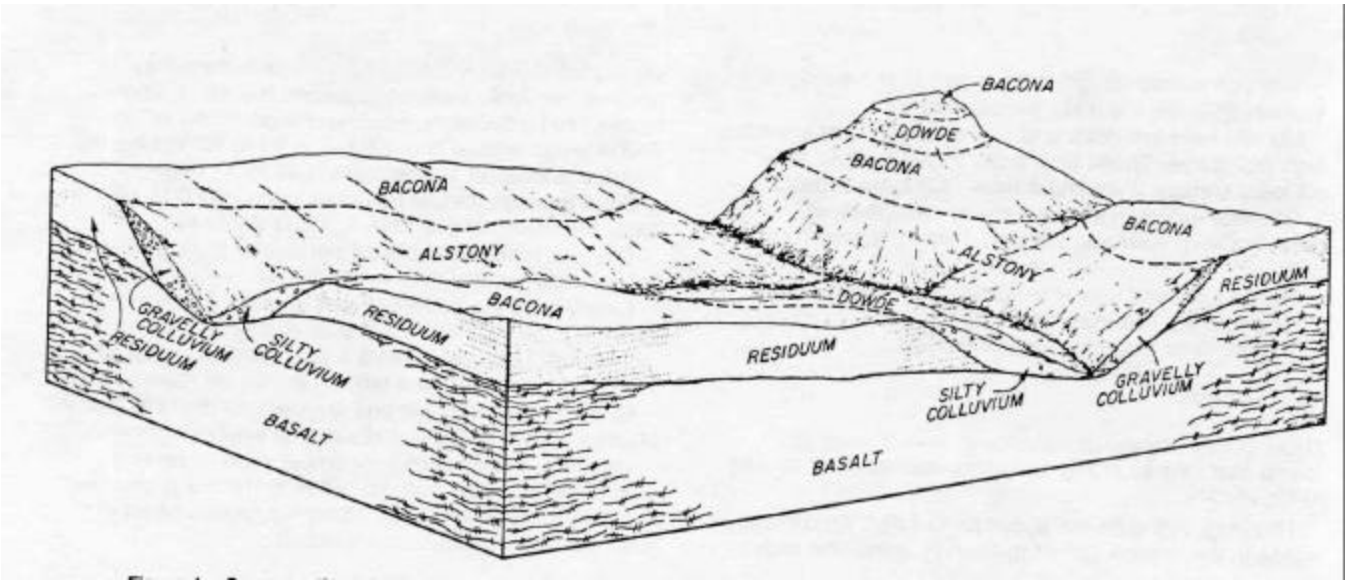


Figure 4. -Cross section of mountains showing relationship of soils, relief, and parent material in general soil map unit 11.

12. Vernonia-Scaponia-Braun

Deep and moderately deep, gently sloping to steep, well drained silt loams that formed in colluvium derived from sedimentary rock

This map unit is on broad, stable ridgetops and side slopes of mountains (fig. 5), dominantly in the southwestern part of the survey area. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, cascade Oregon-grape, salal, and western swordfern. Elevation ranges from 400 to 2,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average annual frost-free period is 100 to 180 days.

This unit makes up about 15 percent of the survey area. Vernonia, Scaponia, and Braun soils are the main components.

Vernonia soils are deep and well drained. They are on broad, stable ridgetops and side slopes of mountains. These soils have a very dark grayish brown silt loam surface layer and a dark brown silty clay loam subsoil.

Scaponia soils are deep and well drained. They are on active, convex slopes of mountains. These soils have a dark brown silt loam surface layer and a dark yellowish brown silt loam subsoil.

Braun soils are moderately deep and well drained. They are on active, convex slopes of mountains. These soils have a dark brown silt loam surface layer and a dark yellowish brown silt loam subsoil.

Of minor extent in this unit are the well drained, loamy Rinearson soils along the Clatsop County line; the somewhat poorly drained, clayey Mayger soils on rolling hills; and the moderately well drained, loamy Glohm soils on stable ridgetops and side slopes.

This unit is used mainly for timber production and wildlife habitat. The main limitations for timber production are poor trafficability on the Vernonia soils and steepness of slope of the Scaponia and Braun soils. Use of heavy equipment when the soils are wet can cause compaction. Use of highlead or other logging systems that fully or partially suspends logs can reduce the disturbance *of* the soil in the steeper areas.

Cold Soils on Mountains

This group consists *of* two map units. It makes up about 6 percent *of* the survey area. The soils in this group are on the higher lying mountains in the central and western parts *of* the county. These soils are characterized by moist summers.

13. Murnen

Deep, gently sloping to very steep, well drained silt loams that formed in colluvium derived from igneous rock and mixed with volcanic ash

This map unit is on the upper part *of* high peaks and ridges in the central and western parts of the survey area. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, cascade Oregon-grape, red huckleberry, salal, and western swordfern. Elevation ranges from 1,500 to 2,240 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 42 to 45 degrees F, and the average annual frost-free period is 60 to 100 days.

This unit makes up about 2 percent of the survey area. Murnen soils are the main components.

Murnen soils are deep and well drained. They are on high mountains. These soils have a dark reddish brown silt loam surface layer and a brown silt loam subsoil.

Of minor extent in this unit are the well drained, gravelly Caterl soils and the well drained, loamy Tolany soils.

This unit is used mainly for timber production and wildlife habitat. The main limitation for timber production is steepness of slope in much of the unit.

14. Tolany

Deep, gently sloping to very steep, well drained silt loams that formed in silty colluvium derived from various kinds of rock

This map unit is on the upper part of high peaks and ridges in the central part of the survey area. The native vegetation is mainly Douglas-fir, western hemlock, western hemlock, western redcedar, red alder, vine maple, red huckleberry, salal, and western swordfern. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 42 to 45 degrees F, and the average annual frost-free period is 60 to 100 days. Elevation ranges from 1,500 to 2,240 feet.

This unit makes up about 4 percent of the survey area. Tolany soils are the main components.

Tolany soils are deep and well drained. They are on convex, broad ridgetops and side slopes of high mountains. These soils have a dark reddish brown silt loam surface layer and a reddish brown silt loam subsoil.

Of minor extent in this unit are the well drained, loamy Murnen soils and the well drained, gravelly Caterl soils.

This unit is used mainly for timber production and wildlife habitat. The main limitation for timber production is poor trafficability. Use of heavy equipment when the soils are wet can cause compaction.

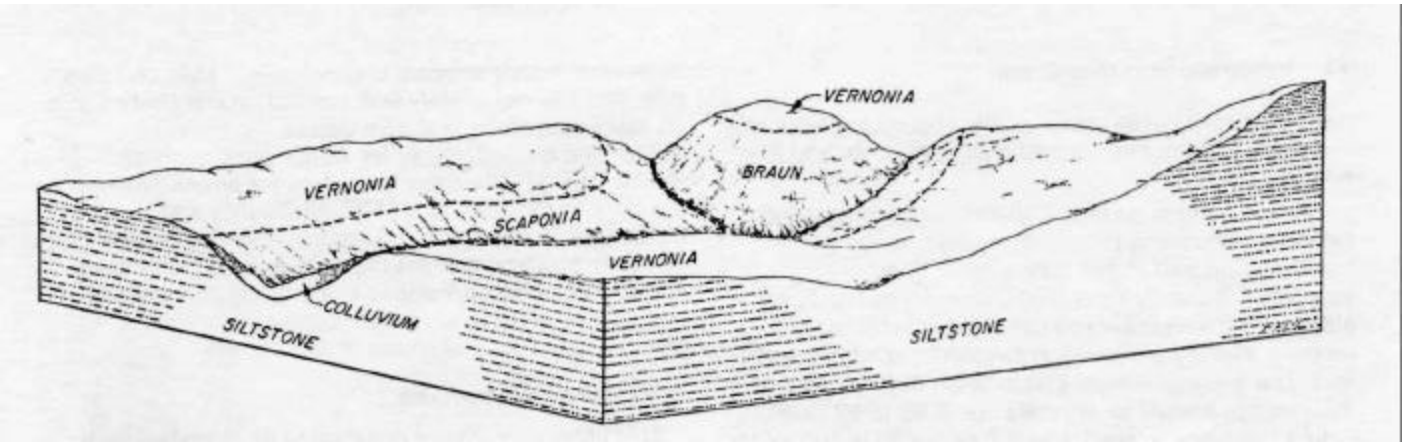


Figure 5.-Cross section of mountains showing relationship of soils, relief, and parent material In general soil map unit 12.

Detailed Soil Map Units

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

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

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

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

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a soil series. Except for differences in texture of the surface layer or of the underlying layers, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying layers. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Cascade silt loam, 3 to 8 percent slopes, is one of several phases in the Cascade series.

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

A complex consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Braun-Scaponia silt loams, 5 to 30 percent slopes, is an example.

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

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables")

give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Map Unit Descriptions

1A-Aloha silt loam, 0 to 3 percent slopes. This deep, somewhat poorly drained soil is on broad terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, willow, trailing blackberry, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the .surface layer is dark brown silt loam about 7 inches thick. The upper 7 inches of the subsoil is mottled, dark brown silt loam, and the lower 26 inches is mottled, dark yellowish brown and brown loam. The substratum to a depth of 60 inches or more is mottled, dark yellowish brown very fine sandy loam. In places the lower part of the subsoil and the upper part of the substratum are a weakly developed hardpan.

Included in this unit are small areas of Quafeno, Quatama, and Wollent soils and Aloha soils that have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability of the Aloha soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more for water-tolerant plants but may be limited to depths between 40 and 60 inches for water-sensitive plants. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 24 inches in winter and early in spring.

This unit is used mainly for crops. It is also used for homesite development, wildlife habitat, and recreation.

If this unit is used for crops, the main limitations are the seasonal high water table and droughtiness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is used for homesite development, the main limitations are seasonal wetness and moderately slow permeability. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Deep drainage reduces the problem of wetness. The beauty of the area can be enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIw.

1B-Aloha silt loam, 3 to 8 percent slopes. This deep, somewhat poorly drained soil is on broad terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, western hazel, willow, trailing blackberry, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The upper 7 inches of the subsoil is mottled, dark brown silt loam, and the lower 26 inches is mottled, dark yellowish brown and brown loam. The substratum to a depth of 60 inches or more is dark yellowish brown very fine sandy loam. In places the lower part of the subsoil and -the upper part of the substratum are a weakly developed hardpan.

Included in this unit are small areas of Aloha Variant, Dayton, Quatama, and Wollent soils and Aloha soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability of this Aloha soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more for water-tolerant plants but is limited to depths between 40 and 60 inches for water-sensitive plants. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 24 inches in winter and early in spring.

This unit is used mainly for crops. It is also used for homesite development, wildlife habitat, and recreation.

If this unit is used for crops, the main limitations are the seasonal high water table, slope, and droughtiness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Grazing when the soil is moist results in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If the soil in the unit is used for homesite development, the main limitations are seasonal wetness, slope, and moderately slow permeability. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitations are seasonal wetness and steepness of slope. Deep drainage reduces the problem of wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIw.

2-Aloha Variant silt loam. This deep, somewhat poorly drained soil is on broad terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Oregon white oak, common snowberry, tall Oregon-grape, western hazel, trailing blackberry, rose, grasses, and forbs. Elevation is 100 to 280 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown and brown silt loam about 15 inches thick. The upper 12 inches of subsoil is brown or yellowish brown, mottled silty clay loam, and the lower 33 inches is light brownish gray, mottled clay. The substratum to a depth of 60 inches or more is clay or silty clay.

Included in this unit are small areas of Aloha, Quatama, and Wollent soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Aloha Variant soil is very slow. Available water capacity is about 5 to 7 inches. Effective rooting depth is 27 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 24 inches in winter and early in spring.

This unit is used mainly for pasture and homesites.

If this unit is used for pasture, the main limitations are seasonal wetness and droughtiness in summer. Drainage and irrigation increase production of pastures. Tile drainage can be used to lower the water table if a suitable outlet is available. Sprinkler irrigation is the most common method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients. Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

If this unit is used for homesite development, the main limitations are seasonal wetness and very slow permeability. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and very slow permeability.

This map unit is in capability subclass IIw.

3E-Alstony gravelly loam, 30 to 60 percent north slopes. This deep, well drained soil is on mountains. It formed in colluvium derived from igneous rock and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, bigleaf maple, vine maple, salal, cascade Oregon-grape, red huckleberry, Oregon oxalis, and western swordfern. Elevation is 300 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the

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

Typically, the surface is covered with a mat of leaves, moss, and twigs 2 inches thick. The surface layer is dark brown gravelly loam about 5 inches thick. The subsurface layer is brown very gravelly loam about 18 inches thick. The substratum is brown very cobbly loam about 21 inches thick over fractured basalt.

Included in this unit are small areas of Bacona and Dowde soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Alstony soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 163. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 173 cubic feet per acre for 60-year-old trees 1.5 inches in diameter at breast height. The potential production per acre of merchantable timber is 97,520 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 123.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to slight erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

3F-Alstony gravelly loam, 60 to 90 percent north slopes. This deep, well drained soil is on mountains. It formed in colluvium derived from igneous rock and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, bigleaf maple, vine maple, salal, cascade Oregon-grape, red huckleberry, Oregon oxalis, and swordfern. Elevation is 300 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown gravelly loam about 5 inches thick. The subsurface layer is brown very gravelly loam about 18 inches thick. The substratum is brown very cobbly loam about 21 inches thick over fractured igneous rock.

Included in this unit are small areas of Bacona and Dowde soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Alstony soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is very high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 163. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 173 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 97,520 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 123.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead or other cable logging methods are most suitable. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to slight erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Locating roads on midslopes results in large cuts and fills and thus removes land from production. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive.

Reforestation can be accomplished. by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIIe.

4E-Alstony gravelly loam, 30 to 60 percent south slopes. This deep, well drained soil is on mountains. It formed in colluvium derived from igneous rock and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, bigleaf maple, vine maple, salal, cascade Oregon-grape, red huckleberry, Oregon oxalis, and western swordfern. Elevation is 300 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown gravelly loam about 5 inches thick. The subsurface layer is brown very gravelly loam about 18 inches thick. The substratum is brown very cobbly loam about 21 inches thick over fractured igneous rock.

Included in this unit are small areas of Bacona and Dowde soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Alstony soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 155. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 164 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, seedling mortality, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to slight erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. The high temperature of the surface layer in summer and moderate available water capacity increase seedling mortality. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

4F-Alstony gravelly loam, 60 to 90 percent south slopes. This deep, well drained soil is on mountains. It formed in colluvium derived from igneous rock and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, bigleaf maple, vine maple, salal, cascade Oregon-grape, red huckleberry, Oregon oxalis, and western swordfern. Elevation is 300 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown gravelly loam about 5 inches thick. The subsurface layer is brown very gravelly loam about 18 inches thick. The substratum is brown very cobbly loam about 21 inches thick over fractured igneous rock.

Included in this unit are small areas of Bacona and Dowde soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Alstony soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is very high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 155. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 164 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, seedling mortality, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead or other cable logging methods are most suitable. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to slight erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Locating roads on midslopes results in large cuts and fills and thus removes land from production. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. The high temperature of the surface layer in summer and moderate available water capacity increase seedling mortality. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIIe.

5D-Anunde silt loam, 3 to 30 percent slopes. This deep, well drained soil is on stable, convex, broad ridgetops of mountains. It formed in colluvium derived from siltstone and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, red huckleberry, cascade Oregon-grape, cascara buckthorn, western brackenfern, and western swordfern. Elevation is 80 to 900 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47 to 53 degrees F, and the average frost-free period is 140 to 210 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark brown and brown silt loam about 17 inches thick. The upper part of the subsoil is dark yellowish brown silt loam about 30 inches thick, and the lower part is dark yellowish brown silty clay loam 13 inches thick.

Included in this unit are small areas of Braun, Scaponia, and Tolke soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Anunde soil is moderate. Available water capacity is about 12 to 14 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 191. The growth at the culmination of mean annual increment (CMAI) for Douglas-fir is 201 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 118,720 board feet (International rule, one-eighth-inch kerf) for an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 141.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using lowground-pressure equipment damages the soil less and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts helps to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. When wet or moist, unsurfaced roads and skid trails are slippery. They may be impassable during the rainy period. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover or an organic mat.

This map unit is in capability subclass VIe.

6D-Bacona silt loam, 3 to 30 percent slopes. This very deep, well drained soil is on stable, convex, broad ridgetops and convex side slopes of mountains. It formed in colluvium derived from siltstone, shale, and sandstone and mixed with loess and volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, red huckleberry, cascade Oregon-grape, salal, American trailplant, and western swordfern. Elevation is 400 to 1,600(feet. The average annual precipitation is about 60 to 75 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, moss, and woody material about 2 inches thick. The surface layer is dark brown silt loam about 6 inches thick. The upper 27 inches of the subsoil is reddish brown silt loam and silty clay loam, and the lower 27 inches is yellowish red silty clay loam.

Included in this unit are small areas of Alstony, Goble, Glohm, and Vernonia soils. Also included are small areas of Kenusky and Mayger soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Bacona soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

This unit is used for timber production, recreation, and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 162. The growth at the culmination of the mean annual increment (CMAI) for 60-year-old Douglas-fir trees 1.5 inches or larger in diameter at breast height is 172 cubic feet per acre. The potential production per acre of merchantable timber is 96,720 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 126.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Presence of undesirable plants prevents adequate natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

7D-Braun-Scaponia silt loams, 5 to 30 percent slopes. This map unit is on stable, convex slopes of mountains. The native vegetation is mainly Douglas-fir, western redcedar, bigleaf maple, vine maple, red alder, cascade Oregon-grape, huckleberry, salal, creambush oceanspray, western brackenfern, broadleaf starflower, and western swordfern. Elevation is 500 to 2,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

This unit is about 50 percent Braun silt loam and about 30 percent Scaponia silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Mayger, Vernonia, and Tolke soils and Braun and Scaponia soils that have slopes of more than 30 percent. Included areas make up about 20 percent of the total acreage.

The Braun soil is moderately deep and well drained. It formed in colluvium derived from siltstone. Typically, the surface is covered with a mat of leaves, twigs, moss, and lichens 2 inches thick. The surface layer is dark brown silt loam 4 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 26 inches thick over fractured soft siltstone. Depth to the soft rock ranges from 20 to 40 inches. The subsoil is 25 to 60 percent soft rock fragments.

Permeability of the Braun soil is moderate. Available water capacity is about 3 to 6 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium to rapid, and the hazard of water erosion is high.

The Scaponia soil is deep and well drained. It formed in colluvium derived from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark brown silt loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown silt loam 25 inches thick. The substratum is dark brown silt loam about 10 inches thick over soft siltstone. Depth to the soft siltstone ranges from 40 to 60 inches. The subsoil is 25 to 60 percent soft rock fragments.

Permeability of the Scaponia soil is moderate. Available water capacity is about 6 to 9 inches. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 171 on the Braun soil. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 182 cubic feet per acre for 60-year-old trees 1.5 inches. or larger in diameter at breast height. The potential production per acre of merchantable timber is 103,600 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 133.

On the basis of a 100-year site curve, the mean site index for Douglas-fir is 165 on the Scaponia soil. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 176 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of

merchantable timber is 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 128.

The main limitations of this unit for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass VIe.

8F-Braun-Scaponia silt loams, 60 to 90 percent north slopes. This map unit is on active, convex, north-facing slopes of mountains. The native vegetation is mainly Douglas-fir, western redcedar, bigleaf maple, vine maple, red alder, cascade Oregon-grape, red huckleberry, creambush oceanspray, western brackenfern, broadleaf twinflower, and western swordfern. Elevation is 500 to 2,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

This unit is about 50 percent Braun silt loam and about 30 percent Scaponia silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Braun and Scaponia soils that have slopes of less than 60 percent, Dowde soils, and Tolke soils. Included areas make up about 20 percent of the total acreage.

The Braun soil is moderately deep and well drained. It formed in colluvium derived from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown silt loam about 4 inches thick. The subsoil is dominantly dark yellowish brown silt loam about 26 inches thick over fractured soft siltstone. Depth to the soft rock ranges from 20 to 40 inches. The subsoil is 25 to 80 percent soft rock fragments.

Permeability of the Braun soil is moderate. Available water capacity is about 3 to 6 inches. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high.

The Scaponia soil is deep and well drained. It formed in colluvium derived from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown and dark yellowish brown silt loam about 32 inches thick. The substratum is dark brown silt loam about 10 inches thick over fractured soft siltstone. Depth to bedrock ranges from 40 to 60 inches. The subsoil is 25 to 55 percent soft rock fragments.

Permeability of the Scaponia soil is moderate. Available water capacity is about 6 to 9 inches. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is very high.

This unit is used mainly for timber. It is also used for recreation and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir on the Braun soil is 176. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 187 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 107,680 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 133.

On the basis of a 100-year site curve, the mean site index for Douglas-fir on the Scaponia soil is 165. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 176 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 128.

The main limitations of this unit for the management of timber are the hazard of erosion, steepness of slope, the hazard of windthrow on the Braun soil, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead or other cable logging methods are the most suitable (fig. 6). Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce surface erosion. When wet or moist, unsurfaced roads and skid trails are

soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Locating roads on midslopes results in large cuts and fills and thus removes land from production. Material cast to the side when building roads can damage vegetation and is a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Because roots are restricted by soil depth, trees on the Braun soil commonly are subject to windthrow. Undesirable plants on this unit limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover or the mat of organic material.

This map unit is in capability subclass VIIe.

9F-Braun-Scaponia silt loams, 60 to 90 percent south slopes. This map unit is on active, convex slopes of mountains. The native vegetation is mainly Douglas-fir, western redcedar, bigleaf maple, vine maple, red alder, cascade Oregon-grape, red huckleberry, salal, creambush oceanspray, western swordfern, broadleaf twinflower, and western swordfern. Elevation is 500 to 2,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

This unit is about 50 percent Braun silt loam and about 30 percent Scaponia silt loam. The components of this

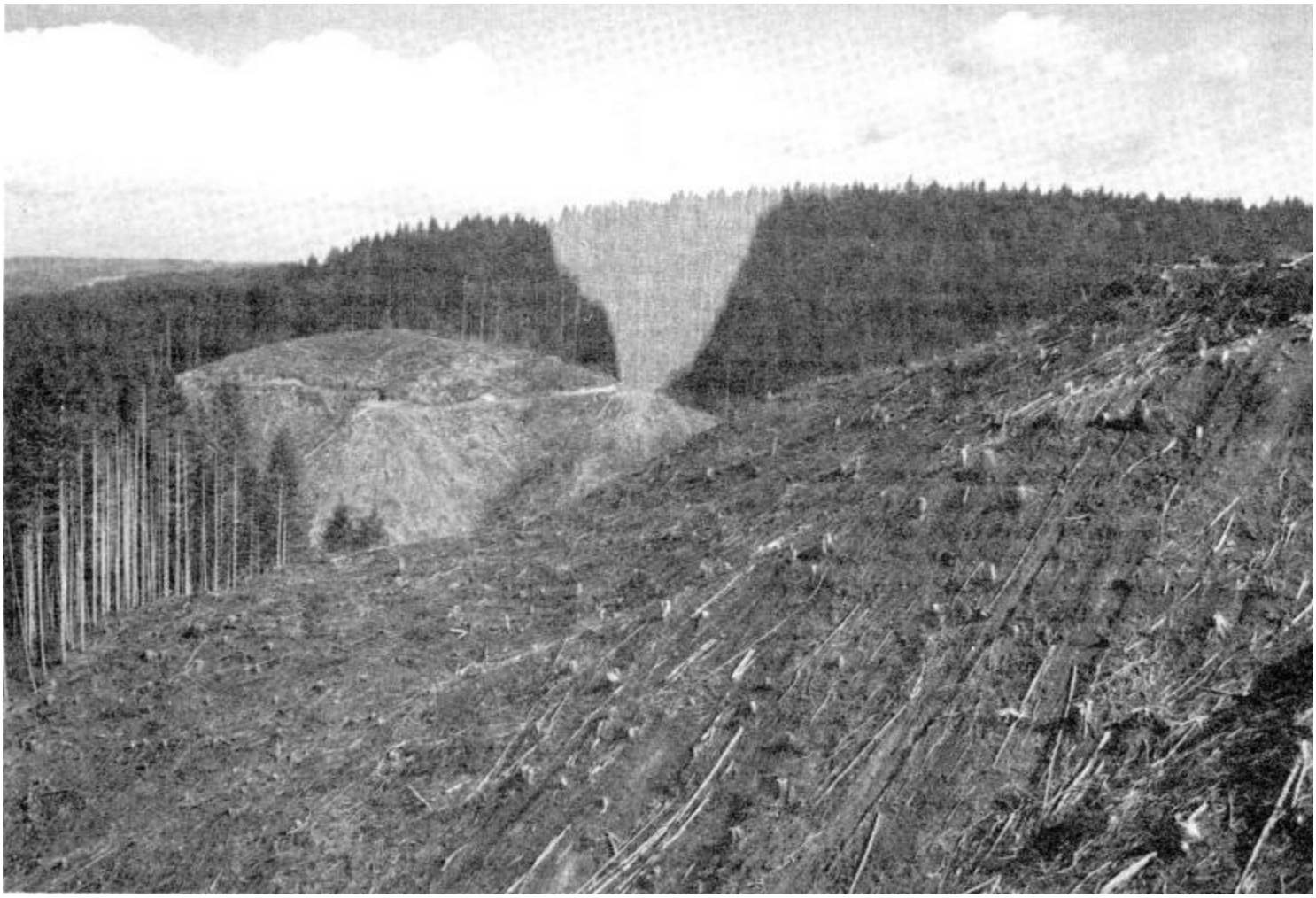


Figure 6.-Area of Braun Scaponia silt loams, 60 to 90 percent north slopes, where cabl ɜ logging has been used to harvest timber.

unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Braun and Scaponia soils that have slopes of less than 60 percent, Dowde soils, and Tolke soils. Included areas make up about 20 percent of the total acreage.

The Braun soil is moderately deep and well drained. It formed in colluvium derived from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown silt loam about 4 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 26 inches thick over fractured soft siltstone. Depth to the soft rock ranges from 20 to 40 inches. The subsoil is 25 to 60 percent soft rock fragments.

Permeability of the Braun soil is moderate. Available water capacity is about 3 to 6 inches. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high.

The Scaponia soil is deep and well drained. It formed in colluvium derived from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss. The surface layer is dark brown silt loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 25 inches thick. The substratum is dark brown silt loam about 10 inches thick over fractured soft siltstone. Depth to the soft rock ranges from 40 to 60 inches. The subsoil is 25 to 55 percent soft rock fragments.

Permeability of the Scaponia soil is moderate. Available water capacity is about 6 to 9 inches. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is very high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir on the Braun soil is 155. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 164 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 117.

On the basis of a 100-year site curve, the mean site index for Douglas-fir on the Scaponia soil is 160. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 176 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 128.

The main limitations of this unit for the management of timber are the hazard of erosion, steepness of slope, the hazard of windthrow on the Braun soil, seedling mortality, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead or other cable logging systems that fully or partially suspend logs are less damaging to the soil and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Locating roads on midslopes results in large cuts and fills and thus removes land from production. Material cast to the side when building roads can damage vegetation and is a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Because roots are restricted by soil depth, trees on the Braun soil commonly are subject to windthrow. Undesirable plants on this unit limit natural or artificial reforestation unless site preparation and maintenance are intensive. The high temperature of the surface layer in summer and moderate available water capacity increase seedling mortality. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover or a mat of organic material.

This map unit is in capability subclass VIIe.

10B-Cascade silt loam, 3 to 8 percent slopes. This moderately deep, somewhat poorly drained soil is on convex, broad ridgetops of low hills. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, salal, vine maple, Pacific trillium, and false-Solomon-seal. Elevation is 300 to 650 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The subsoil is dark brown silt loam about 9 inches thick. Below this to a depth of 60 inches or more is a mottled, dark yellowish brown silt

loam and dark brown silty clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Cornelius and Delena soils and Cascade soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 24 inches and slow below this depth. Available water capacity is about 5 to 7 inches. Effective rooting depth is 20 to 30 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the hardpan at a depth of 18 to 30 inches in winter and early in spring.

This unit is used for crops. It is also used for timber production, homesite development, wildlife habitat, and recreation.

If this unit is used for crops, the main limitations are seasonal wetness, droughtiness in summer, and the hardpan. The perched water table that develops during the rainy period in winter and early in spring generally limits the suitability of the soil in this unit for deep-rooted crops. Most climatically adapted crops can be grown if artificial drainage1s provided. Tile systems are difficult to install because of the shallow depth to the hardpan. Operation of tile systems can be improved by installing them across the slope.

In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Subsoiling should be across the tile lines. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If the soil is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 153. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 162 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 89,320 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 121.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. The perched water table limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If the soil in this unit is used for homesite development, the main limitations are seasonal wetness, the hardpan, and slow permeability. Drainage should be provided if buildings with basements and crawl spaces are constructed. Wetness can be reduced by installing drain tile around footings. The hardpan is rippable and therefore is not a serious limitation for most engineering uses.

Preserving the existing plant cover during construction helps to control erosion. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness, shallow depth to the hardpan, and slow permeability.

If this unit is used for recreational development, the main limitations are seasonal wetness and slow permeability. Deep drainage reduces the problem of wetness. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass IIIw.

10C-Cascade silt loam, 8 to 15 percent slopes. This moderately deep, somewhat poorly drained soil in on convex ridgetops and side slopes of low hills. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, salal, vine maple, Pacific trillium, and false-Solomon-seal. Elevation is 300 to 650 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The subsoil is dark brown silt loam about 9 inches thick. Below this layer to a depth of 60 inches or more is mottled, dark yellowish brown silt loam and dark brown silty clay loam. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Cornelius and Delena soils and Cascade soils that have slopes of less than 8 percent or more than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 24 inches and slow below this depth. Available water capacity is about 5 to 7 inches. Effective rooting depth is 20 to 30 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the hardpan at a depth of 18 to 30 inches in winter and early in spring.

This unit is used mainly for crops. It is also used for timber production, homesite development, wildlife habitat, and recreation.

If this unit is used for crops, the main limitations are seasonal wetness, droughtiness, steepness of slope, and the hardpan. The perched water table that develops during the rainy period in winter and early in spring generally limits the suitability of the soil in this unit for deep-rooted crops. Most climatically adapted crops can be grown if artificial drainage is provided. Tile systems are difficult to install because of the shallow depth to the hardpan. Operation of tile systems can be improved by installing them across the slope.

In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the needs of the crops to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Subsoiling should be across tile lines. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If the soil is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 153. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 162 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 89,320 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 121.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts helps to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft; they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are seasonal wetness, the hardpan, slow permeability, and slope. Drainage should be provided if buildings with basements and crawl spaces are constructed. Wetness can be reduced by installing drain tile around footings. The hardpan is rippable and therefore is not a serious limitation for most engineering uses.

Preserving the existing plant cover during construction helps to control erosion. Excavation for roads and buildings increases the risk of erosion. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. In summer, irrigation is required for lawn

grasses, shrubs, vines, shade trees, and ornamental trees. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Plants that tolerate wetness and droughtiness in summer should be selected if drainage and irrigation are not provided.

The soil in this unit are not suited to standard septic tank absorption fields because of shallow depth to the hardpan and slow permeability.

If this unit is used for recreational development, the main limitations are seasonal wetness, slow permeability, and slope. Deep drainage reduces the problem of wetness. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass IIIe.

10D-Cascade silt loam, 15 to 30 percent slopes. This moderately deep, somewhat poorly drained soil is on convex side slopes of low hills. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, grand fir, western hemlock, bigleaf maple, willow, Pacific dogwood, salal, vine maple, Pacific trillium, and false-Solomonsseal. Elevation is 300 to 650 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The subsoil is dark brown silt loam about 9 inches thick. Below this to a depth of 60 inches or more is a mottled, dark yellowish brown silt loam and dark brown silty clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Cornelius and Delena soils and Cascade soils that have slopes of less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 24 inches and slow below this depth. Available water capacity is about 5 to 7 inches. Effective rooting depth is 20 to 30 inches. Runoff is rapid, and the hazard of water erosion is high. Water is perched above the hardpan at a depth of 10 to 30 inches in winter and early in spring.

This unit is used mainly for pasture and grain crops. It is also used for timber production, homesite development, wildlife habitat, and recreation.

If this unit is used for crops, the main limitations are seasonal wetness, droughtiness, the hardpan, and steepness of slope. The perched water table that develops during the rainy period in winter and early in spring generally limits the suitability of the soil in this unit for deep-rooted crops. Certain crops can be grown if artificial drainage is provided. Tile systems are difficult to install because of the shallow depth to the hardpan and steepness of slope. Operation of tile systems can be improved by installing them across the slope.

In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Subsoiling should be across tile lines. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Limiting tillage for seedbed preparation and weed control reduces runoff and erosion. If the soil is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 153. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 162 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 89,320 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 121.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazards of erosion and windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected by plant

cover, or both. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are seasonal wetness, the hardpan, slow permeability, and slope. Drainage should be provided if buildings with basements and crawl spaces are constructed. Wetness can be reduced by installing drain tile around footings. The hardpan is rippable and therefore is not a serious limitation for most engineering uses.

Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. Cutbanks are not stable and are subject to slumping. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness in summer should be selected if drainage and irrigation are not provided.

The soil in this unit is not suited to standard septic tank absorption fields because of steepness of slope, shallow depth to the hardpan, and slow permeability.

If this unit is used for recreational development, the main limitations are seasonal wetness, slow permeability, and slope. Deep drainage reduces the problem of wetness. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass IVe.

11E-Caterl gravelly silt loam, 30 to 60 percent north slopes. This deep, well drained soil is on mountains. It formed in colluvium derived from igneous rock and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, red huckleberry, vine maple, swordfern, cascade Oregon-grape, and salal. Elevation is 1,500 to 2,240 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown gravelly silt loam about 4 inches thick. The subsurface layer is dark reddish brown gravelly silt loam about 12 inches thick. The substratum is reddish brown extremely gravelly silt loam about 25 inches thick over weathered igneous rock.

Included in this unit are small areas of Murnen and Tolany soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Caterl soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site . index for Douglas-fir is 155. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 164 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,000 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to slight erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected by plant cover, or both. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass Vie.

12E-Caterl gravelly silt loam, 30 to 60 percent south slopes. This deep, well drained soil is on mountains. It formed in colluvium derived from igneous rock and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, red huckleberry, vine maple, western swordfern, cascade Oregon-grape, and salal. Elevation is 1,500 to 2,240 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown gravelly silt loam about 4 inches thick. The subsurface layer is dark reddish brown gravelly silt loam about 12 inches thick. The substratum is reddish brown extremely gravelly silt loam about 25 inches thick over weathered igneous rock.

Included in this unit are small areas of Murnen and Tolany soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Caterl soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 140. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 145 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 82,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 104.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, seedling mortality, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to slight erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected by plant cover, or both. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. The high temperature of the surface layer in summer and moderate available water capacity increase seedling mortality. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

13-Cloquato silt loam. This very deep, well drained soil is in convex areas on flood plains. It formed in recent alluvium. Slope is 0 to 3 percent. Areas are long and narrow in shape and are 10 to 30 acres in size. The vegetation in areas not cultivated is mainly Douglas-fir, black cottonwood, bigleaf maple, Oregon white oak, blackberry, shrubs, and grasses. Elevation is 30 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The subsoil is dark brown silt loam about 39 inches thick. The substratum to a depth of 60 inches or more is brown very fine sandy loam.

Included in this unit are small areas of McBee and Wapato soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cloquato soil is moderate. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate because of overflow. This soil is subject to very brief periods of flooding in winter and early in spring.

This unit is used mainly for hay and pasture. It is also used for recreation and wildlife habitat.

If this unit is used for crops, the main limitation is the hazard of flooding. Most climatically adapted crops planted in spring can be grown. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and

tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Septic tank absorption fields do not function properly during periods of flooding. The risk of flooding can be reduced by the use of dikes.

If this unit is used for recreational development, the main limitation is the hazard of flooding. Protection from flooding is needed. Streambank cutting, erosion caused by overflow, and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass IIw.

14B-Cornellus silt loam, 3 to 8 percent slopes. This moderately deep, moderately well drained soil is on convex ridgetops and side slopes of low hills. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, western hazel, willow, creambush oceanspray, rose, Oregon-grape, common snowberry, Pacific dogwood, salal, grasses, and forbs. Elevation is 350 to 650 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 19 inches thick. The subsoil to a depth of 38 inches is brown silty clay loam. Below this layer to a depth of 60 inches or more is a mottled, brown silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Cascade and Delena soils and Cornelius soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Cornelius soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is 30 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and spring.

This unit is used mainly for crops. It is also used for timber production and for homesite development and wildlife habitat.

If this unit is used for crops, the main limitations are the seasonal high water table and droughtiness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Grazing when the soil is wet result in susceptibility of the surface layer to compaction and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 165. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 176 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 99,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 129.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are wetness, slow permeability, and the hardpan at a depth of 30 to 40 inches. Drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and slow permeability. During the rainy periods, effluent from onsite sewage disposal systems may seep at points downslope.

If this unit is used for recreational development, the main limitation is slow permeability. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIe.

14C-Cornellus silt loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on convex ridgetops and side slopes of low hills. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, western hazel, willow, creambush oceanspray, rose, tall Oregon-grape, common snowberry, Pacific dogwood, salal, grasses, and forbs. Elevation is 350 to 650 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 12 inches thick. The upper 18 inches of the subsoil is brown silt loam, and the lower 8 inches is brown silty clay loam. The next layer to a depth of 60 inches or more is a mottled, brown silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Cascade soils and Cornelius soils that have slopes of less than 8 percent or more than 15 percent. Also included are small areas of Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cornelius soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is 30 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and early in spring.

This unit is used mainly for crops, timber production, and wildlife habitat. It is also used for homesite development.

If this unit is used for crops, the main limitations are a seasonal high water table, droughtiness in summer, and slope. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Limiting tillage for seedbed preparation and weed control reduces runoff and erosion. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 165. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 176 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 99,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 year old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 129.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion.

When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are wetness, slow permeability, the hardpan at a depth of 30 to 40 inches, and slope. Drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and slow permeability. During the rainy periods, effluent from onsite sewage disposal systems may seep at points downslope.

If this unit is used for recreational development, the main limitations are slow permeability and slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by controlling traffic.

This map unit is in capability subclass IIIe.

14D-Cornelius silt loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on convex side slopes of low hills. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, western hazel, willow, creambush oceanspray, rose, tall Oregon-grape, common snowberry, Pacific dogwood, salal, grasses, and forbs. Elevation is 300 to 650 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 12 inches thick. The upper 18 inches of the subsoil is brown silt loam, and the lower 8 inches is brown silty clay loam. Below this layer to a depth of 60 inches or more is a mottled, brown silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Cascade soils and Cornelius soils that have slopes of less than 15 percent or more than 30 percent. Also included are small areas of Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cornelius soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is 30 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and early in spring.

This unit is used mainly for timber production and wildlife habitat. It is also used for crops and homesite development.

If this unit is used for crops, the main limitations are slope, the seasonal high water table, and droughtiness in summer. Certain crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Limiting tillage for seedbed preparation and weed control reduces runoff and erosion. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. Drop structures can be installed in grassed waterways where needed. Grazing when the soil is wet results in compaction of the surface layer, poor tilth; and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 165. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 165 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 99,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 129.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected by plant cover, or both. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If the soil in the unit is used for homesite development, the main limitations are wetness, slope, slow permeability, and the hardpan at a depth of 30 to 40 inches. Drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. Cutbanks are not stable and are subject to slumping. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not. provided.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and slow permeability. Absorption lines should be installed on the contour either in less sloping areas of this unit or less sloping areas of suitable adjacent units.

If this unit is used for recreational development, the main limitations are slope and slow permeability. Steep slopes limit the use of areas of the soil in this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IVe.

15-Crims silt loam, protected. This deep, very poorly drained organic soil is in concave areas of low flood plains of the Columbia River. It formed in partially decomposed herbaceous plant material underlain by silty alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly tussocks, grasses, willow, and Oregon ash. Elevation is 0 to 20 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is black or very dark grayish brown peaty muck about 31 inches thick. The substratum to a depth of 60 inches or more is dark gray silt loam that has lenses of muck or fine sand.

Included in this unit are small areas of Locoda and Wauna soils. Also included are small areas of fill material. Included areas make up about 5 percent of the total acreage.

Permeability of this Crims soil is moderate. Available water capacity is about 16 to 28 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to 12 inches from November to May. This soil is subject to ponding in winter and spring. Runoff is slow, and the hazard of water erosion is slight. This soil is drained by open ditches to lower the water table in spring. Dikes are used to protect the soil from flooding.

This unit is used mainly for hay and pasture. It is also used for crops and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are ponding in winter and trafficability during the rainy season. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and reduces soil compaction.

This unit is suited to crops that are planted in spring. The water table that builds up during the rainy period in winter and spring generally limits the suitability of the unit for deep-rooted crops.

This unit is poorly suited to homesite development. The main limitations are wetness and the low strength of the organic material.

This map unit is in capability subclass IIIw.

16-Dayton silt loam. This deep, poorly drained soil is on terraces. It formed in old alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, willow, common snowberry, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is mottled, dark grayish brown silt loam about 12 inches thick. The upper 17 inches of the subsoil is mottled, dark grayish brown clay,

and the lower 22 inches is dominantly mottled, dark grayish brown clay loam. The substratum to a depth of 60 inches or more is mottled, dark grayish brown sandy loam.

Included in this unit are small areas of Aloha, Wollent, and Quatama soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Dayton soil is very slow. Available water capacity is about 2 to 5 inches. Effective rooting depth is 20 to 30 inches for water-tolerant crops. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to brief periods of ponding in winter and early in spring. The water table is at a depth of 0 to 18 inches in winter and early in spring.

This unit is used for hay and pasture and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are wetness and the hazard of ponding. Wetness limits the choice of plants and the period of cutting or grazing. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Excessive water on the surface can be removed by surface drainage and channel improvements. Subsurface drains can be used to lower the water table if suitable outlets are available.

If this unit is used for recreational development, the main limitations are wetness and the hazard of ponding. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass IVw.

17C-Delena silt loam, 3 to 12 percent slopes. This moderately deep, poorly drained soil is in concave areas of low hills. It formed in silty material. Areas are narrow and irregular in shape and are 10 to 60 acres in size. The vegetation in areas not cultivated is mainly Oregon ash, western redcedar, rose, common snowberry, trailing blackberry, hawthorn, willow, grasses, sedges, and forbs. Elevation is 100 to 650 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The upper 8 inches of the subsoil is dark grayish brown silty clay loam. Below this to a depth of 60 inches or more is a grayish brown silty clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Cornelius and Cascade soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Delena soil is moderate to a depth of 23 inches and very slow below this depth. Available water capacity is about 4 to 6 inches. Effective rooting depth is 20 to 30 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the hardpan from the surface to a depth of 18 inches in winter and spring.

This unit is used for pasture and wildlife habitat.

If this unit is used for pasture, the main limitation is wetness. Wetness limits the choice of plants and the period of cutting or grazing. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Tile systems are difficult to install because of the shallow depth to the hardpan. They can be improved by installing them across the slope.

This map unit is in capability subclass IVw.

18E-Dowde silt loam, 30 to 60 percent north slopes. This deep, well drained soil is on active side slopes of mountains. It formed in colluvium derived from igneous rock. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, Pacific trillium, cascade Oregon-grape, salal, and western swordfern. Elevation is 300 to 1,500 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 3 inches thick. The surface layer is dark reddish brown silt loam about 5 inches thick. The subsoil is reddish brown silt loam about 49 inches thick. The substratum to a depth of 60 inches or more is reddish brown silty clay loam.

Included in this unit are small areas of Alstony and Bacona soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Dowde soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is very rapid, and the hazard of water erosion is high.

This unit is used for timber production, recreation, and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 158. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 168 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 93,520 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 124.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead logging or other systems that fully or partially suspend logs are less damaging to the soil and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion.

Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces sedimentation.

Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of the soil in the unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

19E-Dowde silt loam, 30 to 60 percent south slopes. This deep, well drained soil is on active side slopes of mountains. It formed in colluvium derived from igneous rock. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, Pacific trillium, cascade Oregon-grape, salal, and western swordfern. Elevation is 300 to 1,500 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 3 inches thick. The surface layer is dark reddish brown silt loam about 5 inches thick. The subsoil is reddish brown silt loam about 49 inches thick. The substratum to a depth of 60 inches or more is reddish brown silty clay loam.

Included in this unit are small areas of Alstony and Bacona soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Dowde soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is very rapid, and the hazard of water erosion is high.

This unit is used for timber production, recreation, and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 150. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 158 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 86;800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 119.

The main limitations for the management of timber are steepness of slope, the hazard of erosion, seedling mortality, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead or other cable logging systems are most suitable. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless treated. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Locating roads on midslopes results in large cuts and fills and thus removes land from production. Material cast to the side when building roads can damage vegetation and is a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces sedimentation.

Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. The high temperature of the surface layer in summer and moderate available water capacity increase seedling mortality. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

20-Eilertsen silt loam. This deep, well drained soil is on terraces of major streams in the Coast Range. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, cascade Oregon-grape, red huckleberry, common snowberry, western swordfern, salal, American trailplant, and Oregon oxalis. Elevation is 20 to 800 feet. The average annual precipitation is 60 to 70 inches, the

average annual air temperature is 47 to 53 degrees F, and the average frost-free period is 110 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark brown and very dark grayish brown silt loam about 17 inches thick. The upper 8 inches of the subsoil is dark brown silty clay loam, and the lower 24 inches is dark yellowish brown silt loam and brown loam. The substratum to a depth of 60 inches or more is brown fine sandy loam.

Included in this unit are small areas of Treharne, Natal, and McNulty soils and alluvial fan deposits. In some places along Rock Creek and the Clatskanie River there are Eilertsen soils that have 10 to 20 percent coarse fragments below a depth of 16 inches. Included areas make up about 15 percent of the total acreage.

Permeability of this Eilertsen soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. Some areas of this unit are subject to brief, rare periods of flooding from tributary streams or from the Nehalem River when it is blocked by debris.

This unit is used for hay, pasture, timber production, homesites, recreational development, and wildlife habitat.

This unit has few limitations if used for hay and pasture. Grasses and legumes grow well if adequate fertilizer is used. Using management that maintains optimum vigor and quality of forage plants is a good practice. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer, irrigation is needed for maximum production of most crops.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 162. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 172 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 96,720 board feet (International rule, one-fourth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are susceptibility of the surface layer to compaction and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, it is limited by the rare periods of overflow in some areas. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small seeded plants. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit has few limitations if used for recreational development. A few areas adjacent to streams are subject to streambank erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass IIc.

21D-Glohm silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on convex, broad, stable ridgetops of mountains. It formed in silty material overlying marine sediment. The native vegetation is mainly Douglas-fir, western hemlock, red alder, red huckleberry, salal, cascade Oregon-grape, western swordfern, creambush oceanspray, and Pacific trillium. Elevation is 300 to 1,200 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown and brown silt loam about 5 inches thick. The subsoil is brown silt loam and silty clay loam about 31 inches thick. Below this layer to a depth of 60 inches or more is a mottled, yellowish brown silty clay loam hardpan. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Bacona, Braun, Kenusky, Mayger, Scaponia, and Vernonia soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Glohm soil is moderate to a depth of 36 inches and slow below this depth. Available water capacity is about 6 to 9 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium to rapid, and the hazard of water erosion is moderate to high. Water is perched above the hardpan at a depth of 18 to 40 inches in winter and early in spring. In some areas the hardpan is very weakly expressed.

This unit is used for timber production and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 171 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 96,000 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 125.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazards of erosion and windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are slippery. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Presence of undesirable plants prevents adequate artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are seasonal wetness and slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover or preserving the organic mat. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

22C-Goble silt loam, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on convex, broad ridgetops and side slopes of mountains. It formed in silty material mixed with small amounts of volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, red huckleberry, vine maple, western hazel, cascade Oregon-grape, salal, and western swordfern. Elevation is 650 to 1,000 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The subsoil is dark brown silt loam about 24 inches thick. Below this to a depth of 60 inches or more is a mottled, dark yellowish brown silty clay loam hardpan. Depth to the hardpan ranges from 30 to 48 inches.

Included in this unit are small areas of Bacona, Vernonia, and Glohm soils and Goble soils that have slopes of more than 15 percent. Also included are small areas of Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Goble soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 8 to 10 inches. Effective rooting depth is 30 to 48 inches. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and spring.

This unit is used for timber production, hay and pasture, wildlife habitat, and homesite development.

If this unit is used for hay and pasture, the main limitation is the short growing season. Fertilizer is needed for optimum growth of grasses and legumes. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 144. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 150 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 81,120 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 114.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion.

Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are slippery. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are wetness and the slow permeability of the hardpan. The water table is perched above the pan, and drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and slow permeability. During the rainy season, effluent from onsite sewage disposal systems may seep at points downslope.

If this unit is used for recreational development, the main limitation is the slowly permeable hardpan. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass Vle.

22D-Goble silt loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on convex side slopes of mountains. It formed in silty material mixed with small amounts of volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, red huckleberry, vine maple, western hazel, cascade Oregon-grape, salal, and western swordfern. Elevation is 650 to 1,000 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The subsoil is dark brown silt loam about 24 inches thick. Below this layer to a depth of 60 inches or more is a mottled, dark yellowish brown silty clay loam hardpan. Depth to the hardpan ranges from 30 to 48 inches.

Included in this unit are small areas of Bacona, Vernonia, Scaponia, Glohm, and Cascade soils and Goble soils that have slopes of less than 15 percent. Also included are small areas of Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Goble soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 8 to 10 inches. Effective rooting depth is 30 to 48 inches. Runoff is rapid, and the hazard of water erosion is high. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and spring.

This unit is used mainly for timber production and wildlife habitat. It is also used for hay and pasture and homesite development.

If this unit is used for hay and pasture, the main limitations are the short growing season and slope. Fertilizer is needed for optimum growth of grasses and legumes. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 144. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 150 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 81,120 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 114.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazards of erosion and windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using lowground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are slippery. They may

be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are slope, seasonal wetness, and the slowly permeable hardpan. Drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. Cutbanks are not stable and are subject to slumping. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness, shallow depth to the hardpan, and slow permeability. Absorption lines should be installed on the contour either in less sloping areas of this unit or in less sloping areas of suitable adjacent units. During the rainy season, effluent from onsite sewage disposal systems may seep at points downslope.

If this unit is used for recreational development, the main limitations are steepness of slope and the slowly permeable hardpan. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

23C-Goble silt loam, warm, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on convex, broad ridgetops and side slopes of mountains. It formed in silty material mixed with small amounts of volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder (fig. 7), bigleaf maple, red huckleberry, vine maple, western hazel, cascade Oregon-grape, salal, and western swordfern. Elevation is 300 to 650 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The subsoil is dark brown silt loam about 24 inches thick. Below this to a depth of 60 inches or more is a mottled, dark yellowish brown silty clay loam hardpan. Depth to the hardpan ranges from 30 to 48 inches.

Included in this unit are small areas of Bacona, Vernonia, Glohm, and Cascade soils and Goble soils that have slopes of more than 15 percent. Also included are small areas of Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Goble soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 8 to 10 inches. Effective rooting depth is 30 to 48 inches. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and spring.

This unit is used for hay and pasture, wildlife habitat, and homesite development.

If this unit is used for hay and pasture, the main limitation is the short growing season. Fertilizer is needed for optimum growth of grasses and legumes. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 183 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 104,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 130.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazard of windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are slippery. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Figure 7.-Western red alder in an area of Goble silt loam, warm, 3 to 15 percent slopes.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Presence of undesirable plants prevents adequate artificial or natural reforestation of Douglas-fir unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are seasonal wetness and the slowly permeable hardpan. Drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants

that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Standard septic tank absorption fields may not function properly on this unit during rainy periods because of seasonal wetness and slow permeability. During the rainy periods, effluent from onsite sewage disposal systems may seep at points downslope.

If this unit is used for recreational development, the main limitation is the slow permeability of the hardpan. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

23D-Goble silt loam, warm, 15 to. 30 percent slopes. This moderately deep, moderately well drained soil is on convex side slopes of mountains. It formed in silty material mixed with small amounts of volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, red huckleberry, vine maple, western hazel, cascade Oregon-grape, salal, and western swordfern. Elevation is 300 to 650 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 50 to -54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The subsoil is dark brown silt loam about 24 inches thick. Below this to a depth of 60 inches or more is a mottled, dark yellowish brown silty clay loam hardpan. Depth to the hardpan ranges from 30 to 48 inches.

Included in this unit are small areas of Bacona, Vernonia, Scaponia, Glohm, and Cascade soils and Goble soils that have slopes of less than 15 percent. Also included are small areas of Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Goble soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 8 to 10 inches. Effective rooting depth is 30 to 48 inches. Runoff is rapid, and the hazard of water erosion is high. Water is perched above the hardpan at a depth of 30 to 48 inches in winter and spring.

This unit is used mainly for timber production and wildlife habitat. It is also used for hay and pasture and homesite development.

If this unit is used for hay and pasture, the main limitations are the short growing season and slope. Fertilizer is needed for optimum growth of grasses and legumes. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 183 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 104,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 130.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazards of erosion and windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using lowground-pressure equipment reduces damage to the soil and helps to maintain productivity. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Cutbanks occasionally slump when the soil is saturated. When wet or moist, unsurfaced roads and skid trails are slippery. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the hardpan, trees commonly are subject to windthrow. Presence of undesirable plants prevents adequate artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for homesite development, the main limitations are slope, seasonal wetness, and the slowly permeable hardpan. Drainage should be provided if buildings with basements and crawl spaces are constructed. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. Cutbanks are not stable and are subject to slumping. It is difficult to establish plants in areas that have had the surface layer removed, exposing the hardpan. Mulching and fertilizing cut areas help to establish plants. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness, shallow depth to the hardpan, and slow permeability. Absorption lines should be installed on the contour. During the rainy season, effluent from onsite sewage disposal systems may seep at points downslope.

If this unit is used for recreational development, the main limitations are steepness of slope and the slowly permeable hardpan. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

24-Hapludalfs-Udifluvents complex. This map unit is on recent alluvial bottom lands and on terraces in the Coast Range. Slope is 0 to 3 percent. The native vegetation is mainly Douglas-fir, western redcedar, red alder, western swordfern, and forbs. Elevation is 40 to 800 feet. The average annual precipitation is about 50 to 80 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 145 to 200 days.

This map unit is 60 percent Hapludalfs and 30 percent Udifluvents. The components of the unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of wet, poorly drained, clayey soils. Included areas make up about 10 percent of the total acreage.

A reference profile of Hapludalfs has a surface layer that is very dark brown and brown silt loam about 15 inches thick. The subsoil is dark yellowish brown silty clay loam about 27 inches thick.

A reference profile of Udifluvents has a surface layer that is very dark grayish brown fine sandy loam about 8 inches thick. The substratum to a depth of 60 inches or more is dark brown, brown, and yellowish brown fine sandy loam and loamy very fine sand.

The components of this unit are well drained to poorly drained. The surface layer is silt loam, loam, sandy loam, or gravelly sandy loam. The subsoil is loam, clay loam, gravelly sandy loam, or silt loam. The substratum is strata of sandy, silty, clayey, or gravelly material. Depth to the substratum is a few inches to 40 inches.

Permeability is moderate to slow. Available water capacity is about 4 to 12 inches. Runoff is slow, and the hazard of water erosion is slight to moderate.

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

The site index for Douglas-fir is variable. Management practices that minimize the risk of erosion are essential when harvesting timber.

This map unit is in capability subclass VIe.

25D-Hembre-Klickitat complex, 3 to 30 percent slopes. This map unit is on convex ridgetops and side slopes of mountains in the Coast Range. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red huckleberry, vine maple, cascade Oregon-grape, salal, western swordfern, and Oregon oxalis. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 45 to 51 degrees F, and the average frost-free period is 100 to 180 days.

This unit is about 50 percent Hembre silt loam and 30 percent Klickitat gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Murnen, Tolany, and Tolke soils. Included areas make up about 20 percent of the total acreage.

The Hembre soil is deep and well drained. It formed in colluvium and residuum derived dominantly from basalt. Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark reddish brown silt loam about 16 inches thick. The subsoil is dark brown silt loam about 32 inches thick. Fractured basalt is at a depth of 48 inches. Depth to bedrock ranges from 40 to 60 inches.

Permeability of the Hembre soil is moderate. Available water capacity is about 6 to 12 inches. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is high.

The Klickitat soil is deep and well drained. It formed in colluvium and residuum derived dominantly from basalt. Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark reddish brown gravelly loam about 12 inches thick. The subsoil is dark brown very gravelly clay loam about 46 inches thick. Fractured basalt is at a depth of 58 inches. Depth to bedrock ranges from 40 to 60 inches.

Permeability of the Klickitat soil is moderate. Available water capacity is about 3 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is high.

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

The Hembre soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 171 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 96,000 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 127.

The Klickitat soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 156. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 165 cubic feet per acre for 60-year-old

trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,840 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 123.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass VIe.

25E-Hembre-Klickitat complex, 30 to 60 percent slopes. This map unit is on convex, active side slopes of mountains in the Coast Range. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red huckleberry, vine maple, cascade Oregon-grape, salal, western swordfern, and Oregon oxalis. Elevation is 200 to 1,600 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 45 to 51 degrees F, and the average frost-free period is 100 to 180 days.

This unit is about 50 percent Hembre silt loam and 30 percent Klickitat gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Murnen, Tolany, and Tolke soils. Included areas make up about 20 percent of the total acreage.

The Hernbre soil is deep and well drained. It formed in colluvium and residuum derived dominantly from basalt. Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark reddish brown silt loam about 16 inches thick. The subsoil is dark brown silt loam about 32 inches thick. Fractured basalt is at a depth of 48 inches. Depth to bedrock ranges from 40 to 60 inches.

Permeability of the Hembre soil is moderate. Available water capacity is about 6 to 12 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

The Klickitat soil is deep and well drained. It formed in colluvium and residuum derived dominantly from basalt. Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark reddish brown gravelly loam about 12 inches thick. The subsoil is dark brown very gravelly clay loam about 46 inches thick. Fractured basalt is at a depth of 58 inches. Depth to bedrock ranges from 40 to 60 inches.

Permeability of the Klickitat soil is moderate. Available water capacity is about 3 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

The Hembre soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 171 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 96,000 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 127.

The Klickitat soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 156. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 165 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,840 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 123.

The main limitation for the management of timber is steepness of slope. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Cable yarding systems are safer, reduce damage to soil, and help to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round

use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass VIe.

26C-Kenusky silty clay loam, 0 to 15 percent slopes. This very deep, poorly drained soil is in concave areas on mountain ridgetops. It formed in clayey material. The native vegetation is mainly western redcedar, Douglas-fir, western hemlock, red alder, vine maple, cascade Oregon-grape, western hazel, and western swordfern. Elevation is 500 to 1,200 feet. The average annual precipitation is about 60 to 75 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface layer is black, mottled silty clay loam and silty clay about 13 inches thick. The upper 6 inches of the subsoil is dark gray, mottled silty clay, and the lower 25 inches is dark gray, mottled clay. The substratum to a depth of 60 inches or more is grayish brown, distinctly mottled clay.

Included in this unit are small areas of Mayger, Glohm, and Vernonia soils. Included areas make up abut 20 percent of the total acreage.

Permeability of this Kenusky soil is slow to a depth of 19 inches and very slow below this depth. Available water capacity is about 3 to 4 inches. Effective rooting depth is limited by the water table. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. Water is perched above the claypan in November through May.

This unit is used for wildlife habitat, timber production, and recreation.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 116. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 108 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 59,220 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 93.

The main limitations for the management of timber are seasonal wetness, the hazards of erosion and windthrow, and plant competition. Seasonal wetness limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are sticky. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the claypan, trees commonly are subject to windthrow. Presence of undesirable plants prevents adequate artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir, western hemlock, or western redcedar seedlings.

If this unit is used for recreational development, the main limitations are seasonal wetness, very slow permeability, and clayey texture. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Excess water can be removed by using shallow ditches and providing the proper grade.

This map unit is in capability subclass VIw.

27A-Latourell silt loam, 0 to 3 percent slopes. This deep, well drained soil is on broad valley terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Oregon white oak, Douglas-fir, bigleaf maple, western hazel, common snowberry, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 9 inches thick. The upper 22 inches of the subsoil is dark brown and brown silt loam, and the lower 29 inches is dark yellowish brown and dark brown loam. Depth to bedrock is 60 inches or more.

Included in this unit are small areas of Aloha, Multnomah, and Quatama soils and Xerochrepts, steep. Included areas make up about 10 percent of the total acreage.

Permeability of this Latourell soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for crops and as homesites. It is also used for wildlife habitat and recreation.

If this unit is used for crops, it has few limitations. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be

adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overinrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium.

If this unit is used as homesites, it has few limitations. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreation, it has few limitations. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability class I.

27B-Latourell silt loam, 3 to 8 percent slopes. This deep, well drained soil is on broad valley terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Oregon white oak, Douglas-fir, bigleaf maple, western hazel, common snowberry, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 9 inches thick. The upper 22 inches of the subsoil is dark brown and brown silt loam, and the lower 29 inches is dark yellowish brown and dark brown loam.

Included in this unit are small areas of Aloha, Multnomah, and Quatama soils and Xerochrepts, steep. Included areas make up about 10 percent of the total acreage.

Permeability of this Latourell soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight to moderate.

This unit is used mainly for crops and as homesites. It is also used for wildlife habitat and recreation.

If this unit is used for crops, it has few limitations. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Application of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overinrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used as homesites, it has few limitations. The hazard of erosion is increased if the soil is left exposed during site development. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreational development, the main limitation is steepness of slope. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIe.

28-Locoda silt loam. This deep, very poorly drained soil is on concave, low flood plains of the Columbia River. It formed in silty alluvium derived from mixed sources. Slope is 0 to 3 percent. The native vegetation is mainly willows, Oregon ash, grasses, and tussocks. Elevation is 0 to 10 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is mottled, dark grayish brown silt loam about 10 inches thick. The substratum to a depth of 60 inches or more is mottled, gray silt loam or silty clay loam that has thin lenses of peat or muck.

Included in this unit are small areas of Crims and Wauna soils and Udipsamments. Included areas make up about 15 percent of the total acreage.

Permeability of this Locoda soil is moderately slow. Available water capacity is about 10 to 14 inches. Effective rooting depth is limited by a permanent water table that is at or near the surface and fluctuates daily with the tide changes. Runoff is slow to ponded, and the hazard of water erosion is slight.

Most areas of this unit are used as habitat for wetland wildlife.

This map unit is in capability subclass Vlw.

29-Locoda silt loam, protected. This deep, very poorly drained soil is on concave, low flood plains of the Columbia River. It formed in silty alluvium derived from mixed sources. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly willow, Oregon ash, grasses, and tussocks. Elevation is 0 to 10 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is mottled, dark grayish brown silt loam about 10 inches thick. The substratum to a depth of 60 inches or more is mottled, gray silt loam or silty clay loam that has thin lenses of peat or muck.

Included in this unit are small areas of Crims and Wauna soils and Udipsamments. Also included are small areas of fill material. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of this soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to 12 inches from November to May. This soil is subject to ponding in winter and early in spring. Runoff is slow to ponded, and the hazard of water erosion is slight. This soil is pumped and drained by open ditches to lower the water table in spring. Dikes are used to protect the soil from flooding.

This unit is used mainly for hay and pasture. It is also used for crops, wildlife habitat, and homesites.

If this unit is used for hay and pasture, the main limitations are low soil fertility, ponding in winter, and trafficability during the rainy season. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and reduces soil compaction.

This unit is suited to crops planted in spring. The water table that builds up during the rainy period in winter and early in spring generally limits the suitability of the soil in this unit for deep-rooted crops. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. Tilth and fertility can be improved by returning crop residue to the soil.

If this unit is used for homesite development, the main limitations are ponding, wetness, moderately slow permeability, and low soil strength. Drainage is needed if roads and building foundations are constructed. Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effect of shrinking and swelling. Only trees and shrubs that tolerate wetness should be planted.

This unit is not suited to standard septic tank absorption fields because of wetness and moderately slow permeability.

This map unit is in capability subclass IIIw.

30D-Mayger silt loam, 3 to 30 percent slopes. This deep, somewhat poorly drained soil is on smooth, broad ridgetops of mountains. It formed in residuum and colluvium derived dominantly from shale. The native vegetation is mainly Douglas-fir, western redcedar, western hemlock, red alder, red huckleberry, vine maple, cascade Oregon-grape, salal, western swordfern, creambush oceanspray, rose, and common snowberry. Elevation is 500 to 1,200 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 11 inches thick. The upper 6 inches of the subsoil is dark yellowish brown silty clay loam, and the lower 21 inches is grayish brown, mottled silty clay. The substratum to a depth of 60 inches or more is grayish brown, mottled clay.

Included in this unit are small areas of Bacona, Glohm, Kenusky, and Vernonia soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Mayger soil is moderately slow to a depth of 38 inches and very slow below this depth. Available water capacity is about 5 to 7 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the claypan at a depth of 18 to 36 inches in winter and spring.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas fir is 151. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 159 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 87,680 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 117.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, seasonal wetness, the hazards of erosion and windthrow, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Water perched above the claypan limits the use of equipment to dry periods. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Landsliding and slumping can occur if the soil is disturbed when harvesting timber. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Because roots are restricted by the claypan, trees commonly are subject to windthrow. Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir, western hemlock, or western redcedar seedlings.

If this unit is used for recreational development, the main limitations are slope and seasonal wetness. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Excess water can be removed by using shallow ditches and providing the proper grade.

This map unit is in capability subclass Vle.

31-McBee silt loam. This deep, moderately well drained soil is on high flood plains. It formed in silty alluvium. Slope is 0 to 1 percent. The native vegetation in areas not cultivated is mainly Douglas-fir, ash, black cottonwood, willow, grasses, and forbs. Elevation is 30 to 400 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 26 inches thick. The subsoil is dark yellowish brown and brown, mottled silt loam about 16 inches thick. The substratum to a depth of 60 inches or more is brown, mottled silt loam.

Included in this unit are small areas of Cloquato and Wapato soils, Hapludalfs, and Udifluvents. Included areas make up about 10 percent of the total acreage.

Permeability of this McBee soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate because of overflow. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is subject to frequent periods of flooding in winter.

This unit is used mainly for hay and pasture. It is also used for spring planted crops, recreation, and wildlife habitat.

If this unit is used for hay and pasture and spring planted crops, the main limitations are seasonal wetness, the hazard of flooding, and droughtiness. Most climatically adapted crops planted in spring can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients. Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime.

If this unit is used for homesite development, the main limitations are the hazard of flooding and seasonal wetness. Protection from flooding is needed.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness and the hazard of flooding. Deep drainage reduces the problem of wetness.

If this unit is used for recreational development, the main limitations are the hazard of flooding and seasonal wetness. Protection from flooding is needed. Deep drainage reduces the problem of wetness. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Streambank cutting caused by overflow and sedimentation can also be reduced by maintaining adequate plant cover.

This map unit is in capability subclass IIw.

32-McNulty silt loam. This very deep, well drained soil is on flood plains. It formed in recent alluvium derived from mixed material. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, vine maple, red alder, common snowberry, red huckleberry, swordfern, salal, and grasses. Elevation is 40 to 800 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 110 to 200 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 9 inches thick. The upper 14 inches of the subsoil is dark brown silt loam, and the lower 9 inches is dark brown loam. The upper 8 inches of the substratum is dark yellowish brown sandy loam, and the lower part to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Eilertsen, Natal, and Treharne soils. Also included are poorly drained soils in scars of abandoned meanders along the Nehalem River, west of Mist, and sandy soils on low

flood plains. Included areas make up about 15 percent of the total acreage.

Permeability of this McNulty soil is moderate. Available water capacity is about 8 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate along streambanks or barren soil areas. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

This unit is used for hay, pasture, recreational development, and wildlife habitat.

If this unit is used for hay and pasture, the main limitation is the hazard of flooding. Grasses and legumes grow well if adequate fertilizer is used. Using management that maintains optimum vigor and quality of forage plants is a good practice. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer, irrigation is needed for maximum production of pasture.

If this unit is used for recreational development, the main limitation is the hazard of flooding. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic. Protection from flooding is needed.

This map unit is in capability subclass IIw.

33-Moag silty clay loam. This deep, very poorly drained soil is in concave areas on flood plains. It formed in clayey alluvium. Slopes are 0 to 2 percent. The native vegetation is mainly willow, sedges, cattails, and reed canarygrass. Elevation is 0 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 average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark grayish brown, mottled silty clay loam about 10 inches thick. The subsoil is dark grayish brown, mottled silty clay about 27 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, mottled silty clay.

Included in this unit are small areas of Sauvie and Rafton soils and Xeropsamments. Included areas make up about 10 percent of the total acreage.

Permeability of this Moag soil is slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more but is restricted by the water table. Runoff is slow to ponded, and the hazard of water erosion is moderate because of the hazard of flooding. The water table is at a depth of 0 to 12 inches in winter, in spring, and early in summer. This soil is subject to frequent periods of flooding in May and June.

This unit is used mainly for pasture and wildlife habitat. It is also used for recreational development.

If this unit is used for pasture, the main limitations are the hazard of flooding and wetness. Only those pasture species that can withstand periodic inundation and wetness in winter, in spring, and early in summer are adapted to this unit. Use of proper stocking rates, pasture rotation, and restricted grazing during moist periods helps to keep the pasture in good condition and reduces soil compaction. In some years, supplemental irrigation is also needed. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for recreational development, the main limitation is wetness and the hazard of flooding. Drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

Most areas of this unit provide habitat for wetland wildlife.

This map unit is in capability subclass Vlw.

34A-Multnomah loam, 0 to 3 percent slopes. This deep, well drained soil is on terraces. It formed in old gravelly alluvium. The native vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, Pacific dogwood, vine maple, thimbleberry, rose, blue elderberry, and western swordfern. Elevation is 50 to 100 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 8 inches thick. The subsoil is dark brown loam about 19 inches thick. The upper 7 inches of the substratum is dark brown very gravelly loam, and the lower part to a depth of 60 inches or more is dark brown very gravelly coarse sand.

Included in this unit are small areas of Aloha, Latourell, and Quatama soils and Xerochrepts, steep. Included areas make up about 10 percent of the total acreage.

Permeability of this Multnomah soil is moderate to a depth of 27 inches and rapid below this depth. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more, but it is limited in the lower part of the substratum. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for crops, homesite development, and wildlife habitat. It is also used for timber production.

If this unit is used for crops, it has few limitations. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when

the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus and potassium.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 171 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 96,000 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

There are no serious limitations for the management of timber on this unit. Careful use of wheeled and tracked equipment reduces the disturbance of the protective layer of duff. Proper design of road drainage systems and care in the placement of culverts help to control erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit.

Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

This unit has few limitations for homesite development except for rapid permeability, which may allow untreated effluent to percolate rapidly into ground water. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreational development, it has few limitations. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIs.

35B-Multnomah Variant loam, 0 to 8 percent slopes. This deep, well drained soil is on low terraces. It formed in old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, salal, vine maple, brackenfern, and western swordfern. Elevation is 50 to 200 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown gravelly loam about 20 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very gravelly loamy sand.

Included in this unit are small areas of Alstony and Bacona soils, Dystrochepts, and Udifluvents. Included areas make up about 20 percent of the total acreage.

Permeability of this Multnomah Variant soil is moderate to a depth of 38 inches and rapid below this depth. Available water capacity is about 4 to 6 inches. Effective rooting depth is 24 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for pasture, homesite development, and wildlife habitat.

If this unit is used for pasture, it has few limitations. In summer, irrigation is required for maximum production of pasture. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime.

This unit has few limitations for use as homesites except for rapid permeability, which may allow untreated effluent to percolate rapidly into ground water. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreational development, the main limitation is steepness of slope. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIe.

36D-Murnen silt loam, 3 to 30 percent slopes. This deep, well drained soil is on mountains. It formed in colluvium and residuum derived dominantly from basalt mixed with volcanic ash. The native vegetation is mainly

the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus and potassium.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 171 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 96,000 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

There are no serious limitations for the management of timber on this unit. Careful use of wheeled and tracked equipment reduces the disturbance of the . protective layer of duff. Proper design of road drainage systems and care in the placement of culverts help to control erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit.

Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

This unit has few limitations for homesite development except for rapid permeability, which may allow untreated effluent to percolate rapidly into ground water. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreational development, it has few limitations. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIs.

35B-Multnomah Variant loam, 0 to 8 percent slopes. This deep, well drained soil is on low terraces. It formed in old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, salal, vine maple, brackenfern, and western swordfern. Elevation is 50 to 200 feet. The average annual precipitation is about 50 to 70 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown gravelly loam about 20 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very gravelly loamy sand.

Included in this unit are small areas of Alstony and Bacona soils, Dystrochepts, and Udifluvents. Included areas make up about 20 percent of the total acreage.

Permeability of this Multnomah Variant soil is moderate to a depth of 38 inches and rapid below this depth. Available water capacity is about 4 to 6 inches. Effective rooting depth is 24 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for pasture, homesite development, and wildlife habitat.

If this unit is used for pasture, it has few limitations. In summer, irrigation is required for maximum production of pasture. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime.

This unit has few limitations for use as homesites except for rapid permeability, which may allow untreated effluent to percolate rapidly into ground water. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreational development, the main limitation is steepness of slope. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIe.

36D-Murnen silt loam, 3 to 30 percent slopes. This deep, well drained soil is on mountains. It formed in colluvium and residuum derived dominantly from basalt mixed with volcanic ash. The native vegetation is mainly

Douglas-fir, Pacific trillium, northern bedstraw, Oregon oxalis, salal, western swordfern, cascade Oregon-grape, and red huckleberry. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 42 to 46 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. Typically, the surface layer is dark reddish brown silt loam about 13 inches thick. The subsurface layer is brown silt loam about 28 inches thick. The substratum is brown very gravelly silt loam about 5 inches thick over basic igneous rock.

Included in this unit are small areas of Caterl and Tolany soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Murnen soil is moderate. Available water capacity is about 8 to 10 inches. Effective rooting depth is 40 to 60 inches. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 152. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 161 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 88,480 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are steepness of slope, seedling mortality, and plant competition. Highlead logging or other logging systems that fully or partially suspend logs damage the soil less and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Droughtiness of the surface layer increases seedling mortality, especially on south- and southwest-facing side slopes. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass Vle.

36E-Murnen silt loam, 30 to 60 percent slopes. This deep, well drained soil is on mountains. It formed in colluvium and residuum derived dominantly from basalt and mixed with volcanic ash. The native vegetation is mainly Douglas-fir, Pacific trillium, northern bedstraw, Oregon oxalis, salal, western swordfern, cascade Oregon-grape, and red huckleberry. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 60 to 100 inches, the average annual air temperature is 43 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. Typically, the surface layer is dark reddish brown silt loam about 13 inches thick. The subsurface layer is brown silt loam about 28 inches thick. The substratum is brown very gravelly silt loam about 5 inches thick over basic igneous rock.

Included in this unit are small areas of Caterl and Tolany soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Mumen soil is moderate. Available water capacity is about 8 to 10 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 152. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 161 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 88,480 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are . steepness of slope, the hazard of erosion, seedling mortality, and plant competition. Harvesting of timber is limited mainly by steepness of slope. Highlead or other cable logging methods are most suitable. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste

material minimizes damage to vegetation downslope and reduces the potential for sedimentation. Rock for road construction is readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Droughtiness of the surface layer increases seedling mortality, especially on south- and southwest-facing side slopes. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

37-Natal silty clay loam. This deep, poorly drained soil is in concave areas on low terraces of major streams in the Coast Range. It formed in alluvium derived from mixed material. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly western redcedar, willow, ash, alder, dogwood; spirea, sedges, and rushes. Elevation is 20 to 800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 53 degrees F, and the average frost-free period is 110 to 180 days.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is mottled, very dark grayish brown and dark grayish brown silty clay about 31 inches thick. The substratum to a depth of 60 inches or more is mottled, very dark grayish brown and dark grayish brown silty clay.

Included in this unit are small areas of Eilertsen, McNulty, and Treharne soils and alluvial fan deposits. Included areas make up about 15 percent of the total acreage.

Permeability of the Natal soil is slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of less than 1 foot from November through May. Runoff is very slow or ponded, and the hazard of water erosion is slight.

This unit is used for hay and pasture, recreation, homesite development, and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are ponding and the seasonal high water table. Wetness limits the choice of plants and the period of cutting or grazing. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Use of proper stocking rates, pasture rotation, and restricted grazing during moist periods helps to keep the pasture in good condition and reduces soil compaction.

If this unit is used for homesite development, the main limitations are ponding and the seasonal high water table. Deep drainage reduces wetness. Preserving the existing plant cover during construction helps to control erosion. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided. This unit is not suited to standard septic tank absorption fields because of wetness and slow permeability.

If this unit is used for recreational development, the main limitation is the seasonal high water table. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass IIIw.

38-Natal Variant silty clay loam. This deep, poorly drained soil is in concave areas on flood plains of major streams in the Coast Range. It formed in recent alluvium derived from mixed material. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly western redcedar, willow, Oregon ash, red alder, Pacific dogwood, spirea, sedges, and rushes. Elevation is 20 to 800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 53 degrees F, and the average frost-free period is 110 to 180 days.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is mottled, very dark grayish brown and dark grayish brown silty clay about 31 inches thick. The substratum to a depth of 60 inches or more is mottled, very dark grayish brown and dark grayish brown silty clay.

Included in this unit are small areas of Eilertsen, McNulty, and Treharne soils and alluvial fan deposits. Included areas make up about 15 percent of the total acreage.

Permeability of the Natal soil is slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of less than 1 foot from November through June. Runoff is very slow or ponded, and the hazard of water erosion is slight. This soil is subject to frequent, brief periods of flooding in winter and spring.

This unit is used for hay and pasture, recreation, homesite development, and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are the hazard of flooding and the seasonal high water table. Wetness limits the choice of plants and the period of cutting or grazing. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Use of proper stocking rates, pasture rotation, and restricted grazing during moist periods helps to keep the pasture in good condition and reduces soil compaction.

Plants that tolerate wetness, flooding, and droughtiness should be selected unless drainage and irrigation are provided.

If this unit is used for recreational development, the main limitations are the seasonal high water table and flooding. Erosion and sedimentation can be controlled

and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass IVw.

39A-Quafeno loam, 0 to 3 percent slopes. This deep, moderately well drained soil is on terraces. It formed in silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, tall Oregon-grape, common snowberry, rose, grasses, and forbs. Elevation is 40 to 100 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam and silt loam about 11 inches thick. The subsoil is dark brown, mottled coarse silt loam about 38 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown, mottled coarse silt loam.

Included in this unit are small areas of Sauvie and Sifton soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Quafeno soil is moderately slow. Available water capacity is about 9 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for pasture and other crops, homesite development, and wildlife habitat. It is also used for recreational development.

If this unit is used for pasture and crops, the main limitation is seasonal wetness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of, irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and limit; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitation is seasonal wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIw.

39B-Quafeno loam, 3 to 8 percent slopes. This deep, moderately well drained soil is on terraces. It formed in silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, tall Oregon-grape, common snowberry, rose, grasses, and forbs. Elevation is 40 to 100 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam and silt loam about 11 inches thick. The subsoil is dark brown, mottled coarse silt loam about 38 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown, mottled coarse silt loam.

Included in this unit are small areas of Sauvie and Sifton soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Quafeno soil is moderately slow. Available water capacity is about 9 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for pasture and other crops, homesite development, and wildlife habitat. It is also used for recreational development.

If this unit is used for pasture and crops, the main limitation is seasonal wetness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes,

or grass-legume mixtures help to maintain fertility and filth. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitation is seasonal wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIe.

40A-Quatama silt loam, 0 to 3 percent slopes.
This deep, moderately well drained soil is on broad terraces. It formed in silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The upper 11 inches of the subsoil is dark yellowish brown, mottled silt loam, and the lower 19 inches is dark yellowish brown, mottled silty clay loam and loam. The substratum to a depth of 60 inches or more is dark yellowish brown, mottled loam.

Included in this unit are small areas of Aloha, Dayton, Latourell, and Wollent soils and Xerochrepts, steep. Included areas make up about 10 percent of the total acreage.

Permeability of this Quatama soil is moderately slow. Available water capacity is about 8 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for pasture and other crops, homesites, and wildlife habitat. It is also used for recreational development.

If this unit is used for pasture and crops, the main limitation is seasonal wetness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, potassium.

If this unit is used for homesite development, the main limitation is seasonal wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIw.

40B-Quatama silt loam, 3 to 8 percent slopes.
This deep, moderately well drained soil is on broad terraces. It formed in silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The upper 11 inches of the subsoil is dark yellowish brown, mottled silt loam, and the lower 19 inches is dark yellowish brown, mottled silty clay loam and loam. The substratum to a depth of 60 inches or more is dark yellowish brown, mottled loam.

Included in this unit are small areas of Aloha, Dayton, Latourell, and Wollent soils and Xerochrepts, steep. Included areas make up about 10 percent of the total acreage.

Permeability of this Quatama soil is moderately slow. Available water capacity is about 8 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for pasture and other crops, homesites (fig. 8), and wildlife habitat. It is also used for recreational development.

If this unit is used for pasture and, crops, the main limitation is seasonal wetness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops.

Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

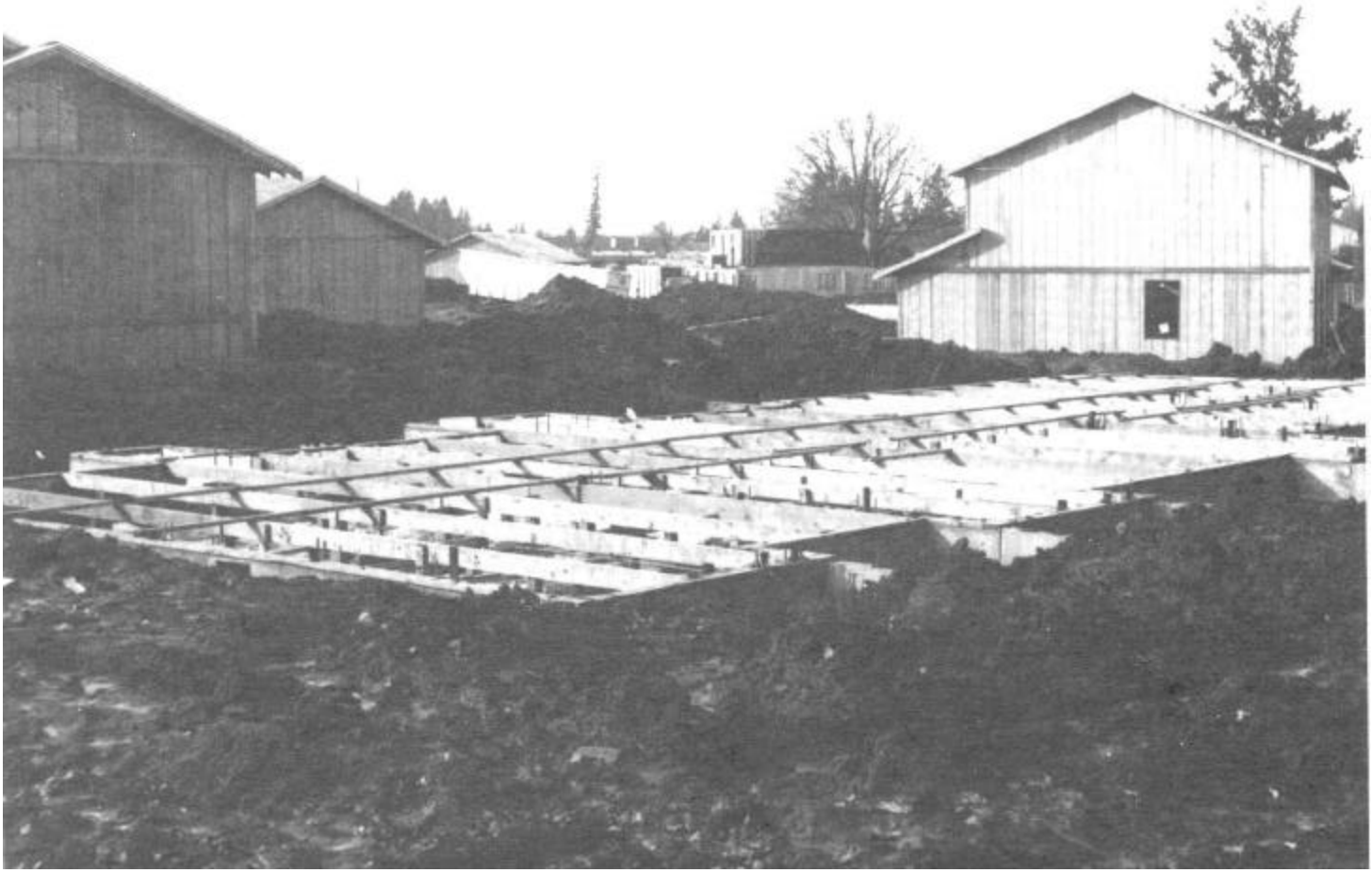


Figure 8.-Homesite development in an area Quatama silt loam, 3 to 8 percent slopes.

If this unit is used for homesite development, the main limitation is seasonal wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIe.

40C-Ouatama silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on broad terraces. It formed in silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, common snowberry, tall Oregon-grape, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 14 inches thick. The upper 11 inches of the subsoil is dark yellowish brown, mottled silt loam, and the lower 19 inches is dark yellowish brown, mottled silty clay loam and loam. The substratum to a depth of 60 inches or more is dark yellowish brown, mottled loam.

Included in this unit are small areas of Aloha, Dayton, Latourell, and Wollent soils and Xerochrepts, steep. Included areas make up about 10 percent of the total acreage.

Permeability of this Quatama soil is moderately slow. Available water capacity is about 8 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for pasture and other crops, homesites, and wildlife habitat. It is also used for recreational development.

If this unit is used for pasture and crops, the main limitations are slope and seasonal wetness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of the plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Limiting tillage for seedbed preparation and weed control reduces runoff and erosion. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are steepness of slope and seasonal wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Excavation for roads and buildings increases the risk of erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit is not suited to standard septic tank absorption fields because of seasonal wetness and moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIe.

41-Rafton silt loam. This deep, very poorly drained soil is on flood plains. It is formed in silty alluvium derived from mixed sources. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly Oregon ash, willow, rose, common snowberry, sedges, cattails, and grasses. Elevation is 10 to 20 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The upper 12 inches of the subsoil is grayish brown silt loam, and the lower 19 inches is mottled, brown and gray silt loam. The upper 15 inches of the substratum is dark grayish brown silt loam, and the lower part to a depth of 60 inches or more is very dark gray silt loam.

Included in this unit are small areas of Moag and Sauvie soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Rafton soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is limited by the water table. The water table is at a depth of 0 to 12 inches in winter and early in spring. This soil is subject to frequent, long periods of flooding in winter and spring.

This unit is used mainly for pasture, wildlife habitat, and recreation.

If this unit is used for pasture, the main limitations are the hazard of flooding and seasonal wetness. Wetness limits the choice of plants and the period of cutting or grazing. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for recreational development, the main limitations are the hazard of flooding and seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass Vlw.

42-Rafton silt loam, protected. This deep, very poorly drained soil is on flood plains. It formed in silty alluvium derived from mixed sources. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly Oregon ash, willow, rose, common snowberry, sedges, cattails, and grasses. Elevation is 10 to 20 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The upper 12 inches of the subsoil is grayish brown silt loam, and the lower 19 inches is mottled, brown and gray silt loam. The upper 15 inches of the substratum is dark grayish brown silt loam, and the lower part to a depth of 60 inches or more is very dark grayish brown silt loam.

Included in this unit are small areas of Moag and Sauvie soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Rafton soil is moderate. Available water capacity is about 11 to 13 inches. Effective rooting depth is limited by the water table. The water table is at a depth of 0 to 12 inches in winter and spring. Although this unit is diked, it can be subject to rare periods of flooding.

This unit is used mainly for hay and pasture. It is also used for sweet corn, spring barley, and snap beans.

If this unit is used for hay and pasture, the main limitation is seasonal wetness. Wetness limits the choice of plants and the period of cutting or grazing. Grazing when the soil is moist results in compaction of the surface layer, poor tilth, and excessive runoff. In some years, supplemental irrigation is also needed. Fertilizer is needed for optimum growth of grasses and legumes.

If this unit is used for recreational development, the main limitations are ponding and seasonal wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

The map unit is in capability subclass IIIw.

43-Rafton-Sauvie-Moag complex. This map unit is on flood plains of the Columbia River. Slope is 0 to 2 percent. The native vegetation on the Moag and Rafton soils is mainly Oregon ash, willow, rose, reed canarygrass, sedges, and cattails, and the native vegetation on the Sauvie soil is mainly black cottonwood, common snowberry, tall Oregon-grape, grasses, and forbs. Elevation is 10 to 20 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is 40 percent Rafton silt loam, 30 percent Sauvie silt loam, and 20 percent Moag silty clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Xeropsamments. Included areas make up about 10 percent of the total acreage.

The Rafton soil is deep and very poorly drained. It formed in recent alluvium derived from mixed sources. Typically, the surface layer is dark brown, mottled silt loam about 8 inches thick. The upper 9 inches of the subsoil is grayish brown, mottled silt loam, and the lower 23 inches is dark grayish brown, mottled silt loam and silty clay loam. The upper 10 inches of the substratum is dark gray, mottled silt loam, and the lower part to a depth of 60 inches or more is dark greenish gray silt loam.

Permeability of this Rafton soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more but is limited by the water table. Runoff is slow to ponded, and the hazard of water erosion is slight. This soil is subject to flooding and ponding in winter and spring. A water table ranges from 1 foot above the soil surface to 1 foot below the surface.

The Sauvie soil is deep and poorly drained. It formed in recent alluvium derived from mixed sources. Typically, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is very dark gray silty clay loam and silt loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown silt loam.

Permeability of this Sauvie soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is

slow, and the hazard of water erosion is slight. This soil is subject to frequent periods of flooding in winter and spring. A water table is within a depth of 1 foot of the surface in winter and spring.

The Moag soil is deep and very poorly drained. It formed in recent alluvium derived from mixed sources. Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The upper 18 inches of the subsoil is dark grayish brown silty clay, and the lower 9 inches is dark gray silty clay. The substratum to a depth of 60 inches or more is dark grayish brown silty clay.

Permeability of this Moag soil is slow. Available water capacity is about 9 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow to ponded, and the hazard of water erosion is slight. This soil is subject to frequent periods of flooding and ponding in winter and spring. A water table ranges from 1 foot above the soil surface to 1 foot below the soil surface.

This unit is used for pasture and wildlife habitat.

If this unit is used for pasture, the main limitations are the hazard of flooding and wetness. Wetness limits the choice of plants and the period of grazing. Using management that maintains optimum vigor and quality of forage plants is a good practice. The use of equipment is. limited by ponding in some areas. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the vegetation in good condition and to protect the soil from erosion.

If this unit is used for recreational development, the main limitations are the hazard of flooding and wetness. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Only trees and shrubs that tolerate wetness should be planted. Flooding can be controlled only by use of major flood control structures.

This map unit is in capability subclass Vlw.

44D-Rinearson silt loam, 3 to 30 percent slopes. This deep, well drained soil is on mountains. It formed in colluvium and residuum derived dominantly from sedimentary rock. The native vegetation is mainly Douglas-fir, western hemlock, bigleaf maple, red alder, vine maple, salal, Pacific trillium, western swordfern, cascade Oregon-grape, American trailplant, and red huckleberry. Elevation is 500 to 1,500 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 45 to 49 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown silt loam about 16 inches thick. The subsurface layer is brown silt loam about 23 inches thick. The substratum is yellowish brown silt loam about 6 inches thick over soft siltstone.

Included in this unit are small areas of Braun, Scaponia, and Vernonia soils and Rinearson soils on the steeper side slopes. Included areas make up about 20 percent of the total acreage.

Permeability of the Rinearson soil is moderate. Available water capacity is about 8 to 10 inches. Effective rooting depth is 40 to 60 inches. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 183 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 104,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 135.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

44E-Rinearson silt loam, 30 to 60 percent slopes. This deep, well drained soil is on mountains. It formed in colluvium and residuum derived dominantly from sedimentary rock. The native vegetation is mainly Douglas-fir, western hemlock, bigleaf maple, red alder, vine maple, salal, Pacific trillium, western swordfern, cascade Oregon-grape, American trailplant, and red huckleberry. Elevation is 500 to 1,500 feet. The average annual precipitation is 70 to 90 inches, the average

annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown silt loam about 16 inches thick. The subsurface layer is brown silt loam about 23 inches thick. The substratum is yellowish brown silt loam about 6 inches thick over soft siltstone.

Included in this unit are small areas of Braun, Scaponia, and Vernonia soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Rinearson soil is moderate. Available water capacity is about 8 to 10 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 183 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 104,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 135.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, steepness of slope, the hazard of erosion, and plant competition. The main limitation for the harvesting of timber is steepness of slope. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Cable yarding systems are safer, damage the soil less, and help to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected by plant cover, or both.

When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation. It is also a potential source of sedimentation. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

45-Rock outcrop-Xerumbrepts complex, undulating. This map unit is on rock-based terraces. Slope is 0 to 10 percent. Mosses and lichens grow on the Rock outcrop. The vegetation on Xerumbrepts is Oregon white oak, poison-oak, and grasses. Elevation is 30 to 200 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is about 50 percent Rock outcrop and 40 percent Xerumbrepts. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of very shallow soils. Included areas make up about 10 percent of the total acreage.

Rock outcrop is exposed areas of basalt.

Xerumbrepts are shallow and well drained. They formed in alluvium. A reference profile of Xerumbrepts has a surface layer that is very dark brown and very dark grayish brown loam about 18 inches thick over basalt. The surface layer ranges from loam, silt loam, and gravelly loam to cobbly loam. Depth to bedrock is 10 to 20 inches.

Permeability of Xerumbrepts is variable. Available water capacity is variable. Effective rooting depth is 10 to 20 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

This unit is used for commercial buildings and homesites. It is also used for recreational development.

This unit is poorly suited to commercial buildings and homesites. The main limitations are depth to bedrock, droughtiness, and slope. Hauling in topsoil, mulching, fertilizing, and irrigation are needed to establish lawn grasses and other small seeded plants. The depth to bedrock can result in high excavation costs when installing water and sewer lines. Conventional septic tank absorption fields do not function properly because of the thin soil layer. Effluent from absorption fields can surface in downslope areas.

This unit is poorly suited to recreational development. The main limitations are the areas of Rock outcrop, gravel and cobbles at the surface, and droughtiness.

This unit is in capability subclass VIIIs.

46-Sauvie silt loam. This deep, poorly drained soil is on flood plains of the Columbia River. It formed in silty alluvium. Slope is 0 to 2 percent. The native vegetation is mainly black cottonwood, Oregon white oak, Oregon ash, common snowberry, rose, tall Oregon-grape, grasses, and forbs. Elevation is 10 to 20 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average 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 very dark gray, mottled silty clay loam and silt loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown silt loam.

Included in this unit are small areas of Moag and Sauvie soils and Xeropsamments. Included areas make up about 15 percent of the total acreage.

Permeability of this Sauvie soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate because of the periods of flooding. The water table is at a depth of 0 to 12 inches in winter and spring. This soil is subject to frequent periods of flooding in winter and spring.

This unit is used mainly for hay and pasture. It is also used for wildlife habitat and recreational development.

If this unit is used for hay and pasture, the main limitations are the hazard of flooding and wetness. Only those hay and pasture plants that can withstand periodic inundation and wetness in winter and spring are suited. In summer, irrigation is required for maximum production of hay and pasture. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime.

This unit is poorly suited to homesite development.

If this unit is used for recreational development, the main limitations are the hazard of flooding and wetness. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass Vlw.

47-Sauvie silt loam, protected. This deep, poorly drained soil is on flood plains of the Columbia River. It formed in silty alluvium. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly Oregon white oak, black cottonwood, common snowberry, rose, tall Oregon-grape, grasses, and forbs. Elevation is 10 to 20 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average 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 very dark gray silty clay loam and silt loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown silt loam.

Included in this unit are small areas of Moag and Rafton soils and Xeropsamments. Included areas make up about 10 percent of the total acreage.

Permeability of this Sauvie soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay, pasture, and other crops. It is also used for wildlife habitat, homesites, and recreational development.

If this unit is used for crops, it has few limitations. Root and horticultural crops are suited to the soil in this unit. In most areas drainage ditches and pumps have lowered the water table to a depth of 5 feet or lower year round. Because this unit is artificially drained, most climatically adapted crops can be grown. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitation is the rare periods of flooding. Dikes on the unit help to control flooding. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of the moderately slow permeability.

If this unit is used for recreational development, the main limitation is the moderately slow permeability. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIw.

48-Sauvie silty clay loam, protected. This deep, poorly drained soil is on flood plains of the Columbia River. It formed in clayey alluvium. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly Oregon white oak, black cottonwood, common

snowberry, rose, tall Oregon-grape, grasses, and forbs. Elevation is 10 to 20 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is very dark gray silty clay loam and silt loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown silt loam.

Included in this unit are small areas of Moag and Rafton soils and Xeropsamments. Included areas make up about 10 percent of the total acreage.

Permeability of this Sauvie soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay, pasture, and other crops. It is also used for wildlife habitat, homesites, and recreational development.

If this unit is used for crops, it has few limitations. In most areas drainage ditches and pumps have lowered the water table to a depth of 5 feet or lower year round. Because this unit is artificially drained, most climatically adapted crops can be grown. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitation is the rare periods of flooding. Dikes on the unit help to control flooding. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of the moderately slow permeability.

If this unit is used for recreational development, the main limitation is the moderately slow permeability. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIw.

49E-Scaponia-Braun silt loams, 30 to 60 percent north slopes. This map unit is on active, convex slopes on mountains in the Coast Range. The native vegetation is mainly Douglas-fir, western redcedar, bigleaf maple, vine maple, red alder, cascade Oregon-grape, red huckleberry, salal, creambush oceanspray, western brackenfern, broadleaf twinflower, and western swordfern. Elevation is 100 to 2,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

This unit is 45 percent Scaponia silt loam and 40 percent Braun silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Bacona, Mayger, and Vernonia soils and small areas of Scaponia and Braun soils that have slopes of less than 30 percent or more than 60 percent. Included areas make up about 15 percent of the total acreage.

The Scaponia soil is deep and well drained. It formed in colluvium derived dominantly from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown silt loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 25 inches thick. The substratum is dark brown silt loam about 10 inches thick over fractured, soft siltstone. Depth to the soft rock ranges from 40 to 60 inches. The subsoil is 30 to 55 percent soft siltstone fragments.

Permeability of the Scaponia soil is moderate. Available water capacity is about 6 to 9 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

The Braun soil is moderately deep and well drained. It formed in colluvium derived dominantly from siltstone. Typically, the surface is covered with a layer of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown silt loam about 4 inches thick. The subsoil is dominantly dark yellowish brown silt loam about 26 inches thick over fractured, soft siltstone. Depth to the soft rock ranges from 20 to 40 inches. The subsoil is 25 to 60 percent soft siltstone fragments.

Permeability of the Braun soil is moderate. Available water capacity is 3 to 6 inches. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

The Scaponia soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 183 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 104,400 board feet (International rule, one-eighth-inch

kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 131.

The Braun soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 176. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 187 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 107,680 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 133.

The main limitations for the management of timber are the hazard of erosion, steepness of slope, the hazard of windthrow on the Braun soil, and plant competition. Highlead logging or other logging systems that fully or partially suspend logs are less damaging to the soil and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected (fig. 9). Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Figure 9.-Erosion of cut and fill slopes in an area of Scaponia-Braun silt loams, 30 to 60 percent north slopes.

Because roots are restricted by soil depth, trees on the Braun soil commonly are subject to windthrow. Undesirable plants on this unit limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover or the mat of organic material.

This map unit is in capability subclass VIe.

50E-Scaponia-Braun silt loams, 30 to 60 percent south slopes. This map unit is on active, convex slopes of mountains in the Coast Range. The native vegetation is mainly Douglas-fir, western redcedar, bigleaf maple, vine maple, red alder, cascade Oregon-grape, red huckleberry, salal, creambush oceanspray, broadleaf twinflower, and western swordfern. Elevation is 100 to 2,000 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

This unit is 45 percent Scaponia silt loam and 40 percent Braun silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Bacona, Mayger, and Vernonia soils and Scaponia and Braun soils that have slopes of less than 30 percent or more than 60 percent. Included areas make up about 15 percent of the total acreage.

The Scaponia soil is deep and well drained. It formed in colluvium derived dominantly from siltstone. Typically, the surface is covered with a mat of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown silt loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 25 inches thick. The substratum is dark brown silt loam about 10 inches thick over fractured, soft siltstone. Depth to the soft rock ranges from 40 to 60 inches. The subsoil is 30 to 55 percent soft siltstone fragments.

Permeability of the Scaponia soil is moderate. Available water capacity is about 6 to 9 inches. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is high.

The Braun soil is moderately deep and well drained. It formed in colluvium derived dominantly from siltstone. Typically, the surface is covered with a layer of leaves, twigs, and moss about 2 inches thick. The surface layer is dark brown silt loam about 4 inches thick. The subsoil is dominantly dark yellowish brown silt loam about 26 inches thick over fractured, soft siltstone. Depth to the soft rock ranges from 20 to 40 inches. The subsoil is 25 to 60 percent soft siltstone fragments.

Permeability of the Braun soil is moderate. Available water capacity is 3 to 6 inches. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is high.

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

The Scaponia soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 170 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 125.

The Braun soil is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 155. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 164 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 118.

The main limitations for the management of timber are the hazard of erosion, steepness of slope, the hazard of windthrow on the Braun soil, seedling mortality, and plant competition. Highlead logging or other logging systems that fully or partially suspend logs are less damaging to the soil and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Because roots are restricted by soil depth, trees on the Braun soil commonly are subject to windthrow. Undesirable plants on this unit limit natural or artificial reforestation unless site preparation and maintenance are intensive. The high temperature of the surface layer in summer and moderate available water capacity

increase seedling mortality. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is steepness of slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover or the mat of organic material.

This map unit is in capability subclass VIe.

51-Sifton loam. This deep, somewhat excessively drained soil is on terraces along the Columbia River. It formed in gravelly alluvium and volcanic ash. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, common snowberry, rose, tall Oregon-grape, grasses, and forbs. Elevation is 30 to 100 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 170 to 210 days.

Typically, the surface layer is black loam about 24 inches thick. The upper 27 inches of the underlying material is dark brown extremely cobbly sand and extremely gravelly sand, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

Included in this unit are small areas of Quafeno and Sauvie soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Sifton soil is moderate to a depth of 24 inches and very rapid below this depth. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for crops, homesite development, and wildlife habitat. It is also used for recreational development.

If this unit is used for crops, the main limitation is droughtiness. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit has few limitations for homesite development except for the very rapid permeability, which may allow untreated effluent to contaminate ground water. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for recreational development, it has few limitations. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIs.

52-Sifton gravelly loam, occasionally flooded. This deep, somewhat excessively drained soil is on flood plains of the Columbia River. It formed in gravelly alluvium and volcanic ash derived from mixed sources. Slope is 0 to 3 percent. The native vegetation is mainly Oregon white oak, common snowberry, rose, forbs, and grasses. Elevation is 10 to 25 feet. The average annual precipitation is 45 inches, the average annual air temperature is 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is black loam about 24 inches thick. The upper 27 inches of the substratum is dark brown extremely cobbly sand, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

Included in this unit are small areas of Sauvie soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Sifton soil is moderate to a depth of 24 inches and very rapid below this depth. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional periods of flooding in May and June.

This unit is used for pasture and wildlife habitat.

If this unit is used for pasture, the main limitations are the hazard of flooding and droughtiness. Use of proper stocking rates, pasture rotation, and restricted grazing during moist periods helps to keep the pasture in good condition and reduces soil compaction. Livestock grazing should be managed to protect the unit from erosion.

This map unit is in capability subclass IIIw.

53D-Tolany loam, 3 to 30 percent slopes. This deep, well drained soil is on convex, broad ridgetops and side slopes of mountains. It formed in silty colluvium derived from mixed sources. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar,

red alder, vine maple, salal, cascade Oregon-grape, red huckleberry, western swordfern, western brackenfern, creambush oceanspray, Pacific trillium, and American trailplant. Elevation is 1,500 to 2,240 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown loam and silt loam about 17 inches thick. The upper 23 inches of the subsoil is reddish brown silt loam, and the lower 20 inches is brown silt loam. Depth to bedrock is 60 inches or more.

Included in this unit are small areas of Murnen and Caterl soils and Tolany soils that have slopes of more than 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability of the Tolany soil is moderate. Available water capacity is about 11 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 141. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 146 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 78,240 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using lowground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

54E-Tolany loam, 30 to 60 percent north slopes. This very deep, well drained soil is on convex, broad ridgetops and side slopes of mountains. It formed in silty colluvium derived from mixed sources. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, salal, cascade Oregon-grape, red huckleberry, western swordfern, western brackenfern, creambush oceanspray, Pacific trillium, and American trailplant. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown loam and silt loam about 17 inches thick. The upper 23 inches of the subsoil is reddish brown silt loam, and the lower 20 inches is brown silt loam. Depth to bedrock is 60 inches or more.

Included in this unit are small areas of Murnen and Caterl soils and Tolany soils that have slopes of less than 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability of the Tolany soil is moderate. Available water capacity is about 11 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 137. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 140 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 74,160 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 113.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, steepness of slope, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Cable yarding systems are safer, damage the soil less, and help to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion.

When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

55E-Tolany loam, 30 to 60 percent south slopes. This very deep, well drained soil is on convex, broad ridgetops and side slopes of mountains. It formed in silty colluvium derived from mixed sources. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, salal, cascade Oregon-grape, red huckleberry, western swordfern, western brackenfern, creambush oceanspray, Pacific trillium, and American trailplant. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 60 to 100 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown loam and silt loam about 17 inches thick. The upper 23 inches of the subsoil is reddish brown silt loam, and the lower 20 inches or more is brown silt loam. Depth to bedrock is 60 inches or more.

Included in this unit are small areas of Murnen and Caterl soils and Tolany soils that have slopes of less than 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability of the Tolany soil is moderate. Available water capacity is about 11 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 144. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 150 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 81,120 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 114.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, steepness of slope, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Cable yarding systems are safer, damage the soil less, and help to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes erode readily unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion.

When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Undesirable plants limit natural or artificial reforestation. Intensive site preparation and maintenance generally are not needed. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This map unit is in capability subclass VIe.

56D-Tolke silt loam, 5 to 30 percent slopes. This very deep, well drained soil is on broad, stable ridgetops and side slopes of mountains. It formed in small amounts of volcanic ash and in colluvium derived dominantly from siltstone and shale. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, red huckleberry, evergreen huckleberry, cascade Oregon-grape, Pacific trillium, salal, Oregon oxalis, and western swordfern. Elevation is 8.00 to 1,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is dark brown silt loam about 18 inches thick. The upper 31 inches of the subsoil is dark brown silty clay loam, and the lower 11 inches or more is brown silty clay loam. Depth to bedrock is 60 inches or more.

Included in this unit are small areas of Anunde, Braun, Scaponia, and Vernonia soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Tolke soil is moderate. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

This unit is used for timber production, recreation, and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 178 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 100,560 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 128.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Displacement of the surface layer occurs most readily when the soil is dry. Puddling can occur when the soil is wet. Using lowground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are slippery. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit artificial or natural reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

57D-Tolke-Alstony complex, 5 to 30 percent slopes. This map unit is on stable, convex, broad ridgetops and convex side slopes of mountains. The native vegetation is mainly Douglas-fir, western redcedar, western hemlock, red alder, vine maple, red huckleberry, evergreen huckleberry, cascade Oregon-grape, Pacific trillium, salal, western swordfern, and Oregon oxalis. Elevation is 300 to 1,800 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free period is 100 to 180 days.

This unit is about 50 percent Tolke silt loam and 30 percent Alstony gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Dowde, Goble, Glohm, and Vernonia soils. Included areas make up about 20 percent of the total acreage.

The Tolke soil is very deep and well drained. It formed in colluvium derived dominantly from siltstone and shale and a small amount of volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, moss, and lichens 2 inches thick. The surface layer is dark brown silt loam 18 inches thick. The upper 31 inches of the subsoil is dark brown silty clay loam, and the lower 11 inches or more is brown silty clay loam. Depth to bedrock is 60 inches or more.

Permeability of the Tolke soil is moderate. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of Water erosion is moderate to high.

The Alstony soil is deep and well drained. It formed in colluvium derived dominantly from igneous rock and a small amount of volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and moss 2 inches thick. The surface layer is dark brown gravelly loam 5 inches thick. The subsoil is brown very gravelly loam 18 inches. The substratum is brown very cobbly loam 21 inches thick over fractured igneous rock. Depth to igneous bedrock ranges from 40 to 60 inches. The substratum has 30 to 70 percent hard rock fragments.

Permeability of the Alstony soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 40 to 60 inches. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

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

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167 on the Tolke soil. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 178 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 100,560 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 130.

On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160 on the Alstony soil. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 170 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 95,200 board feet (International

rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 122.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass VIe.

58-Treharne silt loam. This deep, moderately well drained soil is on terraces of major streams in the Coast Range. It formed in alluvium derived from mixed material. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, red huckleberry, common snowberry, and salal; however, almost all areas have been cleared. Elevation is 20 to 800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 47 to 53 degrees F, and the average frost-free period is 110 to 180 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 15 inches thick. The upper 14 inches of the subsoil is brown silty clay loam, and the lower 12 inches is mottled, brown silty clay loam. The substratum is mottled, dark grayish brown silty clay loam about 14 inches thick over dark gray silty clay that extends to a depth of 60 inches or more.

Included in this unit are small areas of Eilertsen, McNulty, and Natal soils and alluvial fan deposits. Included areas make up about 15 percent of the total acreage.

Permeability of the Treharne soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The water table is at a depth of about 24 to 36 inches in winter and early in spring.

This unit is used for hay, pasture, homesites, recreational development, and wildlife habitat:

If this unit is used for hay and pasture, the main limitation is seasonal wetness. Grasses and legumes grow well if adequate fertilizer is used. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Use of proper stocking rates, pasture rotation, and restricted grazing during moist periods helps to keep the pasture in good condition and reduces soil compaction.

If this unit is used for homesite development, the main limitation is seasonal wetness. Deep drainage reduces wetness. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

This unit has few limitations if used for recreational development. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass IIc.

59-Udifluvents-Dystrochrepts complex. This map unit is on flood plains and on alluvial fans in the Coast Range. It formed in recent alluvium. Slope is 0 to 3 percent. Native vegetation is mainly Douglas-fir, western redcedar, red alder, swordfern, and forbs. Elevation is 40 to 800 feet. The average annual precipitation is about 50 to 80 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 145 to 200 days.

This unit is 50 percent Udifluvents and 30 percent Dystrochrepts. The components of this unit are so intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of wet, poorly drained, clayey soils and Riverwash. Included areas make up about 20 percent of the total acreage.

A reference profile of Udifluvents has a surface layer that is very dark grayish brown fine sandy loam about 8 inches thick. The substratum to a depth of 60 inches or more is dark brown, brown, and yellowish brown fine sandy loam and loamy fine sand.

A reference profile of Dystrochrepts has a surface layer of very dark grayish brown and dark brown silt loam about 9 inches thick. The subsoil to a depth of 60 inches or more is brown silt loam and silty clay loam over dark yellowish brown silty clay loam.

The components of this unit are well drained to poorly drained. The surface layer is loam, silt loam, or gravelly sandy loam. The subsoil is loam, silt loam, sandy loam, or gravelly sandy loam. The substratum is strata of sandy, silty, clayey, or gravelly material. The profile is 5 to 40 inches thick or more.

Permeability is variable. Available water capacity is variable. Runoff is slow, and the hazard of water erosion is slight to moderate.

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

The site index for Douglas-fir is variable. Management practices that minimize the risk of water erosion are essential when harvesting timber.

This unit is in capability subclass Vle.

60-Udipsamments, nearly level. These very deep, excessively drained soils are on flood plains along the Columbia River. They formed in sandy dredge material. Slope is 0 to 3 percent. Large areas are barren or only sparsely vegetated. In areas where vegetation has become established, black cottonwood, willow, trailing blackberry, forbs, and grasses are most common. Elevation is 5 to 20 feet. The average annual precipitation is about 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 145 to 200 days.

A reference profile of Udipsamments, nearly level, has a surface layer that is very dark grayish brown loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown fine sand. Depth to the substratum is 0 to 6 inches.

Included in this unit are small areas of Wauna, Locoda, and Crims soils. Included areas make up about 15 percent of the total acreage.

Permeability of Udipsamments is rapid or very rapid. Effective rooting depth is 60 inches or more. Available water capacity is variable. Runoff is slow, and the hazard of water erosion is slight to moderate. The soils are subject to flooding in May and June. The water table is at a depth of 5 feet or more.

This unit is used mainly for recreational development and wildlife habitat.

If this unit is used for recreational development, the main limitations are flooding and the sandy texture of the soil.

This unit is in capability subclass Vlw.

61-Udipsamments, nearly level, protected. These very deep, excessively drained soils are on flood plains along the Columbia River. They formed in sandy dredge material. Slope is 0 to 3 percent. The unit is protected from flooding by a dike or by sandy dredge material. Large areas of the unit are barren or only sparsely vegetated. In areas where vegetation has become established, black cottonwood, willow, trailing blackberry, forbs, and grasses are most common. Elevation is 10 to 35 feet. The average annual precipitation is about 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 145 to 200 days.

A reference profile of Udipsamments, nearly level, protected, has a surface layer that is very dark grayish brown loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown fine sand. The surface layer is coarse sand, fine sand, or loamy sand. The substratum is sand, gravelly sand, or loamy sand. Depth to the substratum is 0 to 9 inches.

Included in this unit are small areas of Wauna, Locoda, and Crims soils. Also included is about 300 acres of sandy dredge material 2 feet thick or more over silty soil material. The area has a seasonal high water table at a depth of 2 feet in winter and spring. It is immediately south of Port Westward. Included areas make up about 15 percent of the total acreage.

Permeability is rapid or very rapid. Effective rooting depth is 60 inches or more. Available water capacity is variable. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate in some areas. The water table is at a depth of 5 feet or more.

This unit is used mainly for recreation and wildlife habitat.

If this unit is used for recreation, the main limitation is the sandy texture of the soil.

This unit is in capability subclass Vls.

62D-Vernonia silt loam, 3 to 30 percent slopes. This deep, well drained soil is on broad, stable ridgetops and side slopes of mountains. It formed in residuum and colluvium derived dominantly from siltstone and shale. The native vegetation is mainly Douglas-fir, western hemlock, red alder, rose, vine maple, red huckleberry, salal, western swordfern, cascade Oregon-grape, creambush oceanspray, broadleaf starflower, American trailplant, and Pacific trillium (fig. 10). Elevation is 400 to 1,800 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 46 to 50 degrees F, and the average frost-free period is 100 to 180 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 9 inches thick. The subsoil is dark brown silt loam and silty clay loam about 43 inches thick. Sedimentary rock is at a depth of 52 inches. Depth to bedrock ranges from 40 to 60 inches.

Included in this unit are small areas of Bacona, Braun, Glohm, Scaponia, and Tolke soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Vernonia soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 40 to 60 inches. Runoff is medium to rapid, and the hazard of water erosion is moderate to high.

Figure 10. -Douglas-fir, western hemlock, and red huckleberry in an area of Vernonia silt loam, 3 to 30 percent slopes.

This unit is used for timber production, recreational development, and wildlife habitat.

This unit is well suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 159. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 169 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 94,400 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 125.

The main limitations for the management of timber are susceptibility of the surface layer to compaction, the hazard of erosion, and plant competition. Using standard wheeled and tracked equipment when the soil is moist causes rutting and compaction. Puddling can occur when the soil is wet. Using low-ground-pressure equipment reduces damage to the soil and helps to maintain

productivity. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. When wet or moist, unsurfaced roads and skid trails are soft. They may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in this unit.

Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitation is slope. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass VIe.

63-Wapato silt loam. This deep, poorly drained soil is on flood plains. It formed in silty recent alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly ash, willow, cottonwood, red alder, rose, common snowberry, grasses, and forbs. Elevation is 50 to 400 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The upper 9 inches of the subsoil is dark grayish brown silty clay loam, and the lower 21 inches is grayish brown silty clay loam. The substratum to a depth of 60 inches or more is light olive gray silty clay loam.

Included in this unit are small areas of Cloquato and McBee soils, Hapludalfs, and Udifluvents. Included areas make up about 10 percent of the total acreage.

Permeability of this Wapato soil is moderately slow. Available water capacity is 10 to 12 inches. Effective rooting depth is 60 inches or more for water-tolerant plants but is limited to depths between 20 and 30 inches for water-sensitive plants. The water table is at the surface to a depth of 12 inches in winter and early in spring. Runoff is slow, and the hazard of water erosion is moderate because of flooding. This soil is subject to frequent, brief periods of flooding in winter.

This unit is used for pasture, spring planted crops, and wildlife habitat.

If this unit is used for pasture and spring-planted crops, the main limitation is seasonal wetness. Most climatically adapted spring planted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. Only those hay and pasture plants that can withstand periods of inundation and a high water table in winter and early in spring are suited to undrained areas. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most common method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime.

If this unit is used for recreational development, the main limitations are the hazard of flooding and seasonal wetness. Protection from flooding is needed. Good drainage should be provided for paths and trails. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This map unit is in capability subclass IIIw.

64E-Wauld very gravelly loam, 30 to 70 percent slopes. This moderately deep, well drained soil is on active side slopes of mountains. It formed in colluvium derived from basalt. The native vegetation is mainly Douglas-fir, red alder, bigleaf maple, western hemlock, red huckleberry, vine maple, salal, cascade Oregon-grape, western swordfern, longtube twinflower, broadleaf starflower, and Oregon oxalis. Elevation is 400 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 average frost-free period is 145 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown very gravelly loam about 10 inches thick. The upper 6 inches of the subsoil is dark brown very gravelly loam, and the lower 17 inches is dark yellowish brown very gravelly loam. Fractured basalt is at a depth of 33 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Alstony and Dowde soils and Rock outcrop. Included areas make up about 25 percent of the total acreage.

Permeability of this Wauld soil is moderate. Available water capacity is about 2 to 4 inches. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for timber production, recreational development, and wildlife habitat.

This unit is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 143. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 149 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 80,160 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 114.

The main limitations for the management of timber are steepness of slope, the hazards of erosion and windthrow, and plant competition. Harvesting of timber is mainly limited by steepness of slope. Highlead logging or other logging systems that fully or partially suspend logs are less damaging to the soil and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit. Road construction and maintenance costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is also a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Because roots are restricted by soil depth, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope and the high content of coarse fragments. Steep slopes limit the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic. Coarse fragments in the surface layer limit the soil in this unit for some recreational uses.

This map unit is in capability subclass VIIs.

65D-Wauld-Rock outcrop complex, 5 to 30 percent slopes. This map unit is on undulating to steep, low hills. The native vegetation on the Wauld soil is mainly Douglas-fir, red alder, bigleaf maple, western hemlock, red huckleberry, vine maple, salal, cascade Oregon-grape, western swordfern, longtube twinflower, broadleaf starflower, and Oregon oxalis. Lichens grow in areas of Rock outcrop. Elevation is 30 to 400 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is about 50 percent Wauld very gravelly loam and 30 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of shallow and very shallow soils. Included areas make up about 20 percent of the total acreage.

The Wauld soil is moderately deep and well drained. It formed mainly in colluvium. Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown very gravelly loam about 10 inches thick. The upper 6 inches of the subsoil is dark brown very gravelly loam, and the lower 17 inches is dark yellowish brown very gravelly loam. Fractured basalt is at a depth of 33 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Wauld soil is moderate. Available water capacity is about 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

Rock outcrop is exposed areas of basic igneous rock.

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

The Wauld soil is suited to the production of Douglas-fir. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 143. The growth at the culmination of the mean annual increment (CMAI) for Douglas-fir is 149 cubic feet per acre for 60-year-old trees 1.5 inches or larger in diameter at breast height. The potential production per acre of merchantable timber is 80,160 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 114.

The main limitations for the management of timber are steepness of slope, the hazards of erosion and windthrow, and plant competition. Harvesting of timber is mainly limited by steepness of slope. Highlead logging or other logging systems that fully or partially suspend logs are less damaging to the soil and generally are less costly than tractor systems. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Cut and fill slopes are subject to moderate erosion unless they are protected. Seeding, mulching, benching, and compacting can reduce erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are provided with adequate water bars or are protected with plant cover, or both. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in this unit. Road construction and maintenance

costs are greater in the more steeply sloping areas. Material cast to the side when building roads can damage vegetation and is also a potential source of sediment. End hauling of waste material minimizes damage to vegetation downslope and reduces the potential for sedimentation.

Because roots are restricted by soil depth, trees commonly are subject to windthrow. Undesirable plants limit natural or artificial reforestation unless site preparation and maintenance are intensive. Reforestation can be accomplished by planting Douglas-fir seedlings.

If this unit is used for recreational development, the main limitations are steepness of slope, high content of coarse fragments, and areas of Rock outcrop. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic. Coarse fragments in the surface layer limit the soil in this unit for some recreational uses.

This map unit is in capability subclass VIIs.

66-Wauna silt loam, protected. This very deep, poorly drained soil is on flood plains of the Columbia River. It formed in silty alluvium derived from mixed sources. Slope is 0 to 3 percent. The native vegetation is mainly cottonwood, willow, Oregon ash, forbs, and grasses. Elevation is 10 to 20 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark gray silt loam 8 inches thick. The upper part of the substratum is mottled, dark grayish brown silt loam 18 inches thick, and the lower part to a depth of 60 inches or more is mottled, dark grayish brown silt loam stratified with sandy loam or muck.

Included in this unit are small areas of Crims and Locoda soils and Udipsamments. Also included are small areas of fill material. Included areas make up about 10 percent of the total acreage.

Permeability of this Wauna soil is moderately slow. Available water capacity is about 10 to 14 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 36 inches from December to April. Runoff is slow, and the hazard of water erosion is slight. This unit is subject to rare periods of flooding in winter or spring; however, dikes are used to protect the soil from flooding. In most areas drainage ditches and pumps have been used to lower the water table to a depth of 3 feet or lower almost year round.

This unit is used mainly for hay and pasture. It is also used for recreation and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are low soil fertility and wetness. Grasses and legumes grow well if adequate fertilizer is used. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to reduce soil compaction. If not controlled, Canadian thistle and tansy ragwort invade pastures.

If this unit is used for recreational development, the main limitation is wetness. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass IIw.

67-Wauna-Locoda silt loams. This map unit is on flood plains of the Columbia River. Slopes are 0 to 3 percent. The vegetation in areas not cultivated is mainly willows, Oregon ash, grasses, and tussocks. Elevation is 0 to 20 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is 40 percent Wauna silt loam and 40 percent Locoda silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of organic Crims soils and Udipsamments. Included areas make up about 20 percent of the total acreage.

The Wauna soil is deep and poorly drained. It formed in silty alluvium derived from mixed sources. Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is mottled, gray silt loam about 18 inches thick. The substratum to a depth of 60 inches or more is mottled, gray silt loam stratified with sandy loam or muck.

Permeability of this soil is moderately slow. Available water capacity is about 10 to 14 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 24 inches from November to July. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to frequent periods of flooding in May and June.

The Locoda soil is deep and very poorly drained. It formed in silty alluvium derived from mixed sources. Typically, the surface layer is mottled, dark grayish brown silt loam about 10 inches thick. The substratum to a depth of 60 inches or more is mottled, gray silt loam with thin lenses of peat or muck.

Permeability of the Locoda soil is moderately slow. Available water capacity is about 10 to 14 inches. Effective rooting depth is limited by a permanent water table that is at or near the surface and fluctuates daily with the tide changes. The soil is subject to flooding year round. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as habitat for wetland wildlife.

If the Wauna soil is used for pasture, the main limitation is the hazard of flooding. Wetness limits the choice of plants and the period of cutting or grazing.

This unit is poorly suited for homesite development because of the hazard of flooding.

This map unit is in capability subclass Vlw.

68-Wauna-Locoda silt loams, protected. This map unit is on flood plains of the Columbia River. Slopes are 0 to 3 percent. The vegetation in areas not cultivated is mainly willow, Oregon ash, grasses, and tussocks. Elevation is 0 to 20 feet. The average annual precipitation is 50 to 80 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is 40 percent Wauna silt loam and 40 percent Locoda silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Crims soils, Udipsamments, and fill material. Included areas make up about 20 percent of the total acreage.

The Wauna soil is deep and poorly drained. It formed in silty alluvium derived from mixed sources. Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is mottled, gray silt loam about 18 inches thick. The substratum to a depth of 60 inches or more is mottled, gray silt loam stratified with sandy loam or muck.

Permeability of this soil is moderately slow. Available water capacity is about 10 to 14 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 60 inches from December to April. Runoff is very slow, and the hazard of water erosion is slight.

The Locoda soil is deep and very poorly drained. It formed in silty alluvium derived from mixed sources. Typically, the surface layer is mottled, dark grayish brown silt loam about 10 inches thick. The substratum to a depth of 60 inches or more is mottled, gray silt loam or silty clay loam with thin lenses of peat or muck.

Permeability of this soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to 12 inches from November to May. Runoff is very slow to ponded, and the hazard of water erosion is slight.

The lower lying areas of this unit are subject to ponding in winter and spring. Drainage ditches and pumps are used to lower the water table in winter and in spring. Dikes are used to protect the unit from flooding.

This unit is used mainly for hay and pasture. It is also used for recreation and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are low soil fertility, ponding in winter and spring, and wetness. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to reduce soil compaction. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime.

If this unit is used for recreational development, the main limitation is seasonal wetness. Plant cover can be maintained by limiting traffic.

This map unit is in capability subclass IIIw.

69-Wollent silt loam. This deep, poorly drained soil is in minor drainageways and swales of valley terraces. It formed in silty alluvium. Slopes are 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon white oak, willow, Oregon ash, common snowberry, rose, grasses, and forbs. Elevation is 100 to 300 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average 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 grayish brown, mottled silt loam about 45 inches thick. The substratum to a depth of 60 inches or more is grayish brown, mottled silt loam. In places the lower part of the subsoil and the upper part of the substratum are a weakly cemented pan.

Included in this unit are small areas of Aloha, Quatama, and Latourell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Wollent soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches for water-tolerant plants but is limited to depths between 20 and 30 inches for water-sensitive plants. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 0 to 12 inches in winter and spring. In areas that have a weakly cemented pan, water is perched above the pan.

This unit is used mainly for crops, recreational development, and wildlife habitat. It is also used for homesite development.

If this unit is used for crops, the main limitation is seasonal wetness. Most climatically adapted crops can be grown if artificial drainage is provided. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Grazing when the soil is wet results in susceptibility of

the surface layer to compaction, poor tilth, and excessive runoff. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitation is seasonal wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

Standard septic tank absorption fields do not function properly on this unit during rainy periods because of wetness and the moderately slow permeability.

If this unit is used for recreational development, the main limitation is seasonal wetness. Deep drainage reduces the problem of wetness.

This map unit is in capability subclass IIIw.

70E-Xerochrepts, steep. These deep, somewhat poorly drained to well drained soils are on long, narrow escarpments along creeks and in areas where terraces meet bottom lands along the Columbia River. They formed in colluvium and alluvium derived from mixed sources. Slope is 20 to 50 percent. The native vegetation is Douglas-fir, Oregon white oak, bigleaf maple, western hazel, common snowberry, trailing blackberry, rose, forbs, and grasses. Elevation is 50 to 300 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.

A reference profile of Xerochrepts, steep, has a surface layer that is dark silt loam about 14 inches thick. The subsoil is dark brown loam 24 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown fine sandy loam.

Included in this unit are small areas of Latourell and Quatama soils and soils that have slopes of more than 50 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate to moderately slow. Available water capacity is variable. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is high.

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

This unit is suited to timber production. The site index for Douglas-fir is variable. Management practices that minimize the risk of erosion are essential in harvesting timber. Roads and landings can be protected from erosion by constructing water bars and by seeding to grasses. Reforestation should include the reduction of competition from undesirable understory plants. Highlead logging or other logging methods that fully or partially suspend logs are less damaging to soil and generally are less costly than tractor systems.

If this unit is used for pasture, the main limitation is steepness of slope. Grasses and legumes grow well if adequate fertilizer is used. Proper stocking rates, pasture rotation, and restricting grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion.

This map unit is in capability subclass is VIe.

71-Xeropsamments, nearly level. These deep, somewhat excessively drained soils are on flood plains along the Columbia River. They formed in sandy dredge material. Slope is 0 to 3 percent. The unit is subject to frequent periods of flooding. Large areas are barren or only sparsely vegetated. In areas where vegetation has become established, black cottonwood, trailing blackberry, Himalaya blackberry, forbs, and grasses are most common. Elevation is 5 to 20 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

A reference profile of Xeropsamments, nearly level, has a surface layer of very dark grayish brown fine sandy loam about 3 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, stratified fine sand and loamy fine sand. The surface layer is coarse sand, fine sand, or loamy sand. The substratum is sand, gravelly sand, or loamy sand. Depth to the substratum is 0 to 5 inches.

Included in this unit are small areas of Sauvie, Rafton, and Moag soils. Included areas make up about 15 percent of the total acreage.

Permeability is rapid or very rapid. Effective rooting depth is 60 inches or more. Available water capacity is variable. Runoff is slow, and the hazard of water erosion is slight to moderate. The soils are subject to frequent periods of flooding from December to June. Depth to the water table is 5 feet or more.

This unit is used mainly for recreation and wildlife habitat.

If this unit is used for recreational development, the main limitations are the hazard of flooding and the sandy texture of the soil.

This map unit is in capability subclass VIw.

72-Xeropsamments, nearly level, protected. These deep, somewhat excessively drained soils are on flood plains along the Columbia River. They formed in sandy dredge material. Slope is 0 to 3 percent. The unit is protected from frequent flooding by a dike or by sandy dredge material. Large areas are barren or only sparsely vegetated. In areas where vegetation has become established, black cottonwood, trailing blackberry, Himalaya blackberry, forbs, and grasses are most common. Elevation is 10 to 34 feet. The average annual precipitation is about 40 to 50 inches, the average

annual air temperature is 50 to 54 degrees F, and the frost-free period is 165 to 210 days.

Sample profile of Xeropsamments, nearly level, protected, has a surface layer of very dark grayish brown fine sandy loam about 3 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, stratified fine sand and loamy fine sand. The surface layer is coarse sand, fine sand, or loamy sand. The substratum is sand, gravelly sand, or loamy sand. Depth to the substratum is 0 to 5 inches.

Included in this unit are small areas of Sauvie, Rafton, and Moag soils. Included areas make up about 15 percent of the total acreage

Permeability is rapid or very rapid. Effective rooting depth is 60 inches or more. Available water capacity is variable. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate. Depth to the water table is 5 feet or more.

This unit is used mainly for recreation and wildlife habitat.

If this unit is used for recreation, the main limitation is the sandy texture of the soil.

This unit is in capability subclass VIs.

Prime Farmland

In this section, prime farmland is defined and discussed and the prime farmland soils in this survey area are listed.

Prime farmland is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, seed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. Adequate moisture and a sufficiently long growing season are required. Prime farmland soils produce the highest yields with minimal units of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils commonly get an adequate and dependable supply of moisture from precipitation or irrigation. Temperature and growing season are favorable, and level of acidity or alkalinity is acceptable. The soils have few, if any, rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not flooded during the growing season. The slope is no more than 8 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

A recent trend in land use has been the conversion of prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on lands that are less productive than prime farmland.

About 25,737 acres, or about 6 percent, of the survey area, would meet the requirements for prime farmland if adequate drainage, protection from flooding, and an adequate and dependable supply of irrigation water were available. At present, however, only about 15,800 acres, or less than 4 percent of the area, meets the requirements.

The following map units meet the soil requirements for prime farmland when irrigated, drained, or protected from flooding, On some soils included in the list, measures should be used to overcome a hazard or limitation, such as flooding, wetness, or droughtiness. The location of each map unit is shown on the detailed soil maps at the back of this publication. Soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

1A	Aloha silt loam, 0 to 3 percent slopes (if drained)
2	Aloha Variant silt loam (if drained)
10B	Cascade silt loam, 3 to 8 percent slopes (if drained)
13	Cloquato silt loam (if protected from flooding)
14B	Cornelius silt loam, 3 to 8 percent slopes
27A	Latourell silt loam, 0 to 3 percent slopes
27B	Latourell silt loam, 3 to 8 percent slopes
31	McBee silt loam (if drained and protected from flooding)
33	Moag silty clay loam (if drained and protected from flooding)
34A	Multnomah loam, 0 to 3 percent slopes
35B	Multnomah Variant loam, 0 to 8 percent slopes
39A	Quafeno loam, 0 to 3 percent slopes
39B	Quafeno loam, 3 to 8 percent slopes
40A	Quatama silt loam, 0 to 3 percent slopes
40B	Quatama silt loam, 3 to 8 percent slopes
42	Rafton silt loam, protected (if drained)
46	Sauvie silt loam (if drained and protected from flooding)
47	Sauvie silt loam, protected (if drained)
48	Sauvie silty clay loam, protected (if drained)
51	Sifton loam
63	Wapato silt loam (if drained and protected from flooding)
69	Wollent silt loam (if drained)

Use and Management of the Soils

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

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the environment.

Contractors can use this survey to locate sources of sand and pebble, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees c. d shrubs.

Crops and Pasture

General management needed for crops and for hay and pasture is suggested in this section. 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 commonly grown are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil arid the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

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

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

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops

that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Woodland Management and Productivity

James F. McClinton, forester, Soil Conservation Service, prepared this section.

Columbia County is one of the better timber producing areas in North America. The best sites generally are at intermediate elevations; the sites at higher elevations generally produce less timber. Favorable climate, fertile soils, and well suited timber species account for the high productivity in much of the county.

About 75 percent of the county is classified as commercial forest land, and another 1 percent is forested but is not considered to be commercial. About 92 percent of the commercial forest land is privately owned; the rest is publicly owned-3 percent by the federal government, 4 percent by the state, and 1 percent by the county (12).

The wood processing industry is primarily along the Columbia River, which forms the eastern and northern boundaries of the county. There are several mills that produce lumber, plywood, veneer, and paper products and several smaller mills that produce lumber. Much of the wood chips suitable for both high grade and low grade paper products are processed in the county, but some are transported out of the county to domestic and foreign areas. The major specialty mill, which produces western redcedar shake material, is at Mist.

Much of the timber grown in Columbia County is processed in adjoining counties. There is a great deal of interest in increasing current growth rates to meet the needs of local mills and mills in adjoining counties. Growth rates can be increased significantly by applying intensive management practices. Thinning overstocked stands and applying nitrogen to suitable stands on soils that will respond can greatly increase timber yields. Both public and private land managers have begun applying intensive management practices in recent years.

The forest land in the county is protected from fire by the State Department of Forestry and the local fire districts. The increasing population and recreational activities in the county make accidental fires a constant threat, especially during dry periods in summer.

The forested soils in the county are shallow to very deep, gravelly to extremely gravelly, and fine textured to medium textured. Because of differences in climate, topography, and geology, the forests vary in composition and productivity. Open stands of Oregon white oak are at the lower elevations, and dense stands of Douglas-fir are at the higher elevations.

The principle forest cover type (17) is the Pacific Douglas-fir type, which typically has small amounts of western hemlock and western redcedar. The other dominant forest cover type is the Douglas-fir-western

hemlock type. A few true fir trees are on the higher peaks.

The forested areas in the county are affected by many diseases and insects, which may present problems in individual stands of trees. Damage varies from year to year. Douglas-fir has several natural enemies. The principal insect that attacks Douglas-fir is the Douglas-fir beetle *(Dendroctinous pseudotsugae).* Laminated root rot is the most serious fungus enemy of Douglas-fir. Western hemlock is attacked by several trunk, butt, and root rots as well as by the hemlock loopter *(Lambdina fiscellana),* which presents the most serious threat of damage by insects.

Most of the forest land in the county does not provide suitable forage for livestock grazing, but it does provide forage for many species of wildlife. Elk and deer commonly use the forage available in recently harvested areas, and they use dense stands of timber for cover. The most common understory plants are listed in the section "General Soil Map Units."

Soils vary in their ability to produce trees. Depth, fertility, texture, and the available water capacity influence tree growth. Elevation, aspect, soils, and climate determine the kinds of trees that can be expected to grow in any area. Available water capacity and the thickness of the root zone are of major importance. Elevation and aspect are of particular importance in mountainous areas.

Soil surveys are important to forest land managers as they seek ways to increase the productivity of forest land. Some soils respond better to fertilizer than do others, some are more susceptible to landsliding and erosion after roads are built and timber is harvested, and some require special effort when harvesting timber and reforesting. Each map unit in this survey suitable for producing timber presents information concerning forest land productivity and limitations for harvesting timber and names common forest understory plants. Table 6 summarizes the forestry information given in the detailed map unit descriptions. The soils are rated for a number of factors to be considered in management. In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Equipment limitations ratings refer to the limits placed upon the use of equipment, year-round or seasonally, as a result of soil characteristics. A rating of *slight* indicates that use of equipment is not normally restricted in kind or time of year because of soil factors; *moderate* indicates a seasonal limitation because of soil wetness, a fluctuating water table, susceptibility to compaction, or some other factor, and *severe* indicates a seasonal limitation, a need for special equipment (such as a cableyarding logging system), or a hazard in the use of equipment. Steepness of slope, wetness, and susceptibility of the soil to compaction are the main factors that cause equipment limitations. As slope gradient and length increase, it becomes more difficult to use wheeled equipment. Where slopes are even steeper, tracked equipment cannot be operated safely and more sophisticated systems must be used. Soil wetness, especially in combination with fine soil texture, can severely limit the use of equipment, making harvesting practical only during dry periods.

Seedling mortality ratings refer to the probability or mortality of naturally occurring or planted tree seedlings as influenced by kinds of soil or topography. Plant competition is not considered in this rating. The ratings apply to seedlings from good stock that are planted properly during a period of sufficient soil moisture. *slight* indicates that no problem is expected under usual conditions; *moderate* indicates that some problems of mortality can be expected and that extra precautions are advisable; and *severe* indicates that mortality will be high and extra precautions are essential for successful reforestation. Wetness of the soil, droughtiness of the surface layer (especially on south- and southwest-facing side slopes), or position on ridgetops account for seedling mortality problems. To offset these limitations, larger than usual planting stock, special site preparation, surface drainage, or reinforcement plantings may be needed.

Ratings of *windthrow hazard* consider the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees normally are not blown down by wind; *moderate* indicates that an occasional tree may blow down during periods of excessive wetness combined with strong winds; and severe indicates that many trees may be expected to be blown down during periods of soil wetness and moderate or strong winds. Restricted rooting depth because of a high water table, underlying bedrock, an impervious layer, and poor anchoring of roots because the surface layer and subsoil are loose make trees more subject to windthrow. Moderate and severe rating indicate the need for more care in thinning the edges of timber stands, a plan calling for periodic salvage of windthrown trees, and an adequate road and trail system to allow for salvage operations.

Ratings of *plant competition* refer to likelihood of invasion of brushy plants when openings are made in the tree canopy. A rating of *slight* indicates that unwanted brushy plants are not likely to delay the establishment of natural regeneration and that planted seedlings have good prospects for development without undue competition; moderate indicates that competition can be expected to reduce natural or planted seedlings without intensive site preparation and maintenance; and severe indicates that competition can be expected to prevent adequate natural or planted seedlings unless intensive site preparation and maintenance are provided. Favorable climate and productive soils encourage plant competition. Generally, brush invades less as elevation increases. The key to predicting brush competition

problems commonly is the quantity and proximity of seed sources of undesirable plants. Moderate and severe ratings indicate the need for careful and thorough postharvest cleanup in preparation for reforestation and the possibility of mechanically or chemically treating brush to retard the growth and allow seedlings to develop.

The *potential productivity* of important trees on a soil is expressed as a *site index.* This index is determined by taking height and age measurements on selected trees within stands of a given species. The procedure and technique for doing this are given in the site index tables used for the survey area (5, 10, 11). The site index applies to fully stocked, even-aged, unmanaged stands. The highest timber yields, expressed in board feet and cubic feet, can be expected from map units that have the highest site indexes. Site indexes can be converted into estimated yields at various ages by using the appropriate yield tables (5, 11). Important trees are listed in the same order as that of their general occurrence, observed on the soil map unit. Usually, only one or two tree species are dominant.

Trees to plant are those that are used for reforestation or, if suitable conditions exist, natural regeneration. Species listed are suited to the soils and will produce a commercial wood crop. Desired product, topographic position, and personal preference are three factors of many that can influence the choice of trees to use for reforestation.

Recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for dwellings without basements and for local roads and streets in table 8 and interpretations for septic tank absorption fields in table 9.

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

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

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

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

Wildlife Habitat

R. A. Corthell, biologist, Soil Conservation Service, assisted in preparing this section.

Columbia County is characterized by a mild, seasonally wet marine climate. The high producing woodland is at relatively low elevations, and it is bounded on the northern side by the Columbia River estuary and its associated bottom lands. These areas are habitat for large numbers of wintering waterfowl and shore birds. Many kinds of fur-bearing animals abound along the streams in the county, and most of the habitat for the rare and endangered Columbia white-tailed deer in Oregon is on the Columbia River flood plain. The timber-producing woodland provides a diversity of habitat for many elk and deer, especially along the edge of clearcut areas. The streams provide spawning and rearing habitat for the valuable anadromous fish, including salmon,

steelhead trout, and cutthroat trout. Adult anadromous fish destined for the Columbia River system annually travel upstream, and the young fish travel downstream to the ocean.

The Columbia River and its sloughs and backwaters provide habitat for many species of warm-water fish. The unique and valuable white sturgeon inhabits the Columbia River, and large runs of smelt travel up the Columbia River to suitable spawning areas each spring.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

The map units in the county that have similar characteristics have been grouped according to their potential for wildlife habitat. These groups are described in the following paragraphs.

Genera/ map units 1 and 3.- The soils in these units are on flood plains of the Columbia River and its tributaries. They are deep, nearly level, and poorly drained and very poorly drained. The soils along the Columbia River are subject to flooding in May and June, and the soils in basin-like areas are subject to ponding from November to June. Elevation is dominantly 0 to 20 feet, but it ranges to 200 feet along the upper reaches of Scappoose Creek. The average annual precipitation is 40 to 80 inches, which occurs mainly as rainfall in fall and winter. The average annual air temperature is 50 to 54 degrees F, and the average annual frost-free season is 165 to 210 days.

The native plant community on these soils reflects the influence of a mild climate and a long growing season.

These map units are particularly important as wintering areas for waterfowl and shore birds. Many fur-bearing animals, such as mink, muskrat, beaver, otter, raccoon, skunk, and fox, find suitable habitat in areas of wetlands, rivers, and streams. The rare and endangered Columbia white-tailed deer inhabits the islands and lowlands. Other animals that commonly use these soils include black-tailed deer, coyote, wood rat, squirrels, rabbits, and many small rodents.

Important birds that use the soils in these units as habitat include the bald eagle, hawks, owls, jays, crows, ravens, gulls, blackbirds, swallows, sandhill crane, woodpeckers, ruffed grouse, ring-necked pheasant, pigeons, and many other kinds of small birds.

The Columbia River and its backwaters are inhabited by many kinds of fish, including salmon, steelhead and other trout, warmwater fish, white sturgeon, Columbia River smelt, and several kinds of rough fish.

General soil map units 4, 5, 6, and 7.-The soils in these units are on the terraces and low foothills along the Columbia River. These soils are deep and shallow, nearly level to moderately steep, and somewhat excessively drained to somewhat poorly drained. Elevation is 30 to 650 feet. The average annual precipitation is 40 to 60 inches, which occurs mainly as rainfall in fall and winter. The average annual air temperature is 50 to 54 degrees F, and the average annual frost-free season is 165 to 210 days.

These map units are used as homesites and for pastures. The native vegetation is extensive woodland dominated by Douglas-fir and western redcedar.

The mild climate, long growing season, and clearing of much of the woodland along the edge of clearcut areas has resulted in a lot of habitat for black-tailed deer, elk, and black bear. Other animals that use the habitat on these units include skunk, raccoon, coyote, fox, bobcat, oppossum, squirrels, rabbits, and many small rodents. Bird life includes hawks, owls, bald eagle, crows, ravens, jays, swallows, band-tailed pigeon, woodpeckers, blue grouse, ruffed grouse, and many small birds. The many tributary streams that drain this area contain cutthroat trout, Coho salmon, and steelhead trout.

General soil map unit 2.-The soils in this unit are on flood plains and terraces of the Nehalem and Clatskanie Rivers and other streams of the Coast Range. These soils are deep, nearly level, and well drained and moderately well drained. The lower lying areas are subject to flooding in winter. Elevation ranges from 20 to 800 feet. The average annual precipitation is 60 to 70 inches, which occurs mainly as rainfall in fall and winter. The average annual air temperature is 47 to 53 degrees F, and the average annual frost-free season is 110 to 180 days.

These soils are used mainly for pasture. The native vegetation is dominated by Douglas-fir, alder, salmonberry, and trailing blackberry. The cool summers and short growing season limit the choice of crops grown. These soils provide habitat for elk, deer, black bear, bobcat, coyote, mink, beaver, otter, squirrels, and several kinds of rodent. Bird life includes hawks, owls, mergansers, kingfishers, jays, ravens, herons, swallows, and ruffed grouse.

Most of the streams provide spawning and rearing habitat for salmon, steelhead trout, and cutthroat trout.

General soil map units 8, 9, 10, 11, 12, 13, and 14.- The soils in these units are on uplands of the Coast Range. These soils are deep and moderately deep, gently sloping to very steep, and well drained and moderately well drained. Elevation ranges from 80 to 2,240 feet. The average annual precipitation is 60 to 100 inches, most of which occurs as rainfall in fall and winter. The average annual air temperature is 42 to 53 degrees F, and the average annual frost-free season is 60 to 210 days.

The soils in these units are mainly highly productive woodland. The native vegetation is dominated by Douglas-fir, western hemlock, western redcedar, and red alder. The understory vegetation is mainly salal, red

huckleberry, Cascade Oregon-grape, and western swordfern.

This group provides habitat for elk, deer, black bear, coyote, bobcat, wood rat, marten, squirrels, and rodents. Bird life includes hawks, owls, jays, ravens, woodpeckers, band-tailed pigeon, blue grouse, ruffed grouse, mountain quail, and many small birds such as wrens, chickadees, and warblers.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building Site Development, Sanitary Facilities, Construction Materials, and Water Management. The ratings are based on observed performance of the soils and on the estimated data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of pebble, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps and soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 8 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

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

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic

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

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of pebble, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a pan and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 9 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered slight if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 9 also shows the suitability of the soils for use as daily cover for landfills. A rating of good indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; fair indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and poor indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

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

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

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

Table 9 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a pan, flooding, large stones, and content of organic matter.

Excessive seepage because of rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 9 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained off site, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess pebble are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the finial cover.

Construction Materials

Table 10 gives information about the soils as a source of roadfill, sand, pebble, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and pebble. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

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

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or pebble or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and pebbles are used in many kinds of construction. Specifications for each use vary widely. In table 10, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

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

A soil rated as a *probable* source has a layer of clean sand or pebbles or a layer of sand or pebbles that is as much as 12 percent silty fines. This material must be at least 3 feet thick and less than, 50 percent, by weight, large stones. All other soils are rated as an *improbable* source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and pebbles.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a, water table, soil

texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no pebbles, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated fair are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of pebbles, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated poor are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of pebbles, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 11 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered slight if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

Pond reservoir *areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a pan, large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

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

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

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. Low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features listed in tables are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 12 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

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

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

Classification of the soils is determined according to the system adopted by the American Association of State Highway and Transportation Officials (2, 15) and the Unified soil classification system (3).

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

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

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

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

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

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

Physical and Chemical Properties

Table 13 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

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

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to absorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1 /3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are low, a change of less than *3* percent; *moderate, 3* to 6 percent; and *high,* more than 6 percent. Very *high,* greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, very fine sand, sand, and organic matter (up to 4 percent) and on soil structure and permeability. The estimates are modified by the presence of rock fragments. Values of K range from 0.02 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table *13,* the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the

soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Tables 14 and 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

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

Table 14 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; occasional that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as very *brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of pebble, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 14 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. A water table that is seasonally high for less than 1 month is not indicated in the table.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An *artesian* water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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

Depth to bedrock is given in table 15 if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the

water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, and acidity. The rate of corrosion of concrete is based mainly on the texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as low, moderate, or high, is based on soil drainage class and total acidity.

For concrete, the risk of corrosion is also expressed as low, moderate, or high. It is based on soil texture and acidity.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (22). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 16 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in sol. An example is Inceptisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Umbrept (Umbr, meaning shade, plus ept, from Inceptisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplumbrepts (Hapl, meaning minimal horizonation, plus umbrept, the suborder of the Inceptisols that have an Umbric epipedon).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective Typic identifies the subgroup that typifies the great group. An example is Typic Haplumbrepts.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplumbrepts.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (21).* Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (22). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aloha Series

The Aloha series consists of deep, somewhat poorly drained soils on broad terraces. These soils formed in alluvium. Slope is 0 to 8 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of an Aloha silt loam; 25 feet north of Slaven Road; in the NW1/4 of sec. 25, T. 4 N., R. 2 W., Willamette Meridian.

Ap-0 to 7 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine

roots; many very fine irregular pores; common fine concretions 2 to 8 millimeters in diameter; medium acid; clear smooth boundary.

B1-7 to 14 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; few fine distinct yellowish brown (10YR 5/4) and yellowish red (5YR 4/8) mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; few fine hard black concretions; slightly acid; clear smooth boundary.

B2-14 to 27 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; many medium distinct dark brown (7.5YR 4/4) and yellowish red (5YR 4/6) mottles and few medium distinct dark grayish brown (10YR 4/2) mottles; few black stains; moderate medium subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; slightly brittle; few very fine roots; few very fine tubular pores; slightly acid; clear smooth boundary.

B3-27 to 40 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; many medium distinct grayish brown (2.5Y 5/2, 5/3) and yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; slightly brittle; few fine roots; few very fine tubular pores; slightly acid; clear smooth boundary.

IIC-40 to 60 inches; dark yellowish brown (10YR 3/4), grayish brown (2.5Y 5/2), and yellowish red (5YR 4/6) very fine sandy loam, pale brown (10YR 6/3) dry; few thin organic coatings; massive; hard, firm, slightly sticky and slightly plastic; slightly brittle; few fine roots; few coarse, fine, and very fine tubular pores; medium acid.

The A horizon has value of 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry.

The B2 horizon has value of 4 or 5 when moist, and it has chroma of 3 or 4 above a depth of 20 inches and 2 to 4 below a depth of 20 inches. Mottles are faint to distinct throughout; mottles in chroma of 2 or less are above a depth of 30 inches. The B2 horizon is silt loam or loam and has 18 to 27 percent clay and less than 15 percent sand that is coarser than very fine sand. The lower part of the B2 horizon is a slightly brittle to very weak fragipan. It has few to continuous coatings of clean, gray sand and silt grains.

Aloha Variant

The Aloha Variant consists of deep, somewhat poorly drained soils on broad terraces. These soils formed in alluvium derived from mixed material. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of an Aloha Variant silt loam; 100 feet south of Fir Road; in the NW1/4 of sec. 8, T. 4 N., R. 1 W., Willamette Meridian.

A11-0 to 4 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; few fine soft concretions; medium acid; clear smooth boundary.

A12-4 to 9 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/3) dry; moderate fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; few fine soft concretions; medium acid; abrupt smooth boundary.

B1-9 to 15 inches; brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21t-15 to 20 inches; brown (7.5YR 4/4) silty clay loam, light brown (7.5YR 6/4) dry; many medium distinct strong brown mottles; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; many fine and very fine pores; few thin clay films in pores; medium acid; clear smooth boundary.

B22t-20 to 27 inches; yellowish brown (10YR 5/4) heavy silty clay loam, light yellowish brown (10YR 6/4) dry; many distinct strong brown and yellowish red mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common fine and very fine tubular pores; few thin clay films in pores; medium acid; clear smooth boundary.

IIB22t-27 to 35 inches; light brownish gray (10YR 6/2) clay, light brownish gray (10YR 7/2) dry; moderate medium to coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; common very fine tubular pores; common thin clay films in pores; medium acid; clear smooth boundary.

IIB3-35 to 60 inches; light brownish gray (2.5Y 6/2) light clay, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; common very fine tubular pores; strongly acid.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B2 horizon is silt loam or silty clay loam. It has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when dry.

The IIB2 horizon is clay, silty clay, or heavy silty clay loam. It has hue of 10YR or 2.5Y, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 2 or 3.

Alstony Series

The Alstony series consists of deep, well drained soils on steep side slopes of mountains. These soils formed in colluvium derived from igneous rock and mixed with volcanic ash. Slope is 5 to 90 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of an Alstony gravelly loam; 0.25 mile south of Little Clatskanie River bridge on Apiary Road; in the SE1/4NW1/4 of sec. 27, T. 6 N., R. 3 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, moss, and woody material.
A1-0 to 5 inches; dark brown (10YR 3/3) gravelly loam, brown (10YR 4/3) dry; weak very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots; many very fine irregular pores; 20 percent basalt pebbles; medium acid; clear wavy boundary.
B21-5 to 11 inches; brown (7.5YR 4/4) very gravelly loam, yellowish brown (10YR 5/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, weakly smeary; common fine and medium roots; many very fine and fine tubular pores; 35 percent basalt pebbles and 5 percent basalt cobbles; medium acid; gradual wavy boundary.
B22-11 to 23 inches; brown (7.5YR 4/4) very gravelly loam, yellowish brown (10YR 5/4) dry; moderate very fine subangular blocky structure; hard, friable, slightly sticky and plastic; 40 percent basalt pebbles and 5 percent basalt cobbles; medium acid; gradual wavy boundary.
C-23 to 44 inches; brown (7.5YR 4/4) very cobbly loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; 40 percent basalt cobbles and 20 percent basalt pebbles; medium acid; gradual wavy boundary.
R-44 inches; fractured basalt.

The solum is 20 to 35 inches thick. Depth to bedrock is 40 to 60 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 3 or 4 when dry. The horizon is 15 to 30 percent pebbles.

The B horizon is very gravelly loam or very gravelly silt loam. It has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. The horizon is 30 to 50 percent pebbles and 5 to 20 percent cobbles.

The C horizon is very cobbly loam or very cobbly silt loam. It is 10 to 40 percent pebbles and 20 to 50 percent cobbles.

Anunde Series

The Anunde series consists of very deep, well drained soils on broad ridges of mountainous areas. These soils formed in colluvium derived from siltstone and mixed with volcanic ash. Slope is 3 to 30 percent. The average annual precipitation is about 80 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of an Anunde silt loam; 50 feet east of logging road and 2,000 feet northeast of the SW1/4 of sec. 9, T. 7 N., R. 5 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, and moss.
A11-0 to 8 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/3) dry; strong very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic, weakly smeary; many very fine and common fine roots; many very fine irregular pores; common hard concretions 2 to 5 millimeters in diameter; very strongly acid; clear smooth boundary.
A12-8 to 17 inches; brown (7.5YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, weakly smeary; many very fine and common fine roots; many very fine tubular pores; common hard concretions 2 to 5 millimeters in diameter; strongly acid; clear smooth boundary.
B21-17 to 34 inches; dark yellowish brown (10YR 4/4) silt loam, very pale brown (10YR 7/4) dry; moderate medium subangular blocky structure; few very fine and fine roots; few very fine tubular pores; medium acid; gradual wavy boundary.
B22-34 to 47 inches; dark yellowish brown (10YR 4/4) silt loam, very pale brown (10YR 7/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; weakly smeary; few very fine and fine roots; few very fine tubular pores; medium acid; gradual wavy boundary.
B23-47 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, very pale brown (10YR 7/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, sticky and plastic; weakly smeary; few very fine and fine roots; few very fine tubular pores; medium acid.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2

to 4 when moist and 3 or 4 when dry. The horizon is 0 to 5 percent basalt pebbles.

The B horizon is silt loam or silty clay loam. It has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 4 or 5 when moist. It is 2 to 15 percent basalt pebbles.

Bacona Series

The Bacona series consists of very deep, well drained soils on broad, convex, stable ridgetops and convex side slopes of mountains. These soils formed in ash and loess mixed with colluvium derived from siltstone, shale, and sandstone. Slope is 3 to 30 percent. The average annual precipitation is about 70 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of a Bacona silt loam; in the SE1/4SE1/4 of sec. 21, T. 6 N., R. 3 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, moss, and woody material.
A11-0 to 3 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/3) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 15 percent concretions 1 to 5 millimeters in diameter; strongly acid; abrupt smooth boundary.
A12-3 to 6 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 4/4) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 20 percent concretions 1 to 5 millimeters in diameter; strongly acid; clear smooth boundary.
B1-6 to 12 inches; reddish brown (5YR 4/4) silt loam, yellowish red (5YR 5/6) 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 concretions 1 to 5 millimeters in diameter; strongly acid; clear smooth boundary.
IIB21t-12 to 33 inches; reddish brown (5YR 4/4) silty clay loam, yellowish red (5YR 5/6) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; few thin clay films in pores; 10 percent concretions 1 to 5 millimeters in diameter; strongly acid; gradual wavy boundary
IIB22t-33 to 50 inches; yellowish red (5YR 4/6) silty clay loam, yellowish red (5YR 5/8) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; few thin and moderately thick clay films on peds and in pores; strongly acid; gradual wavy boundary.
IIB3t-50 to 60 inches; yellowish red (5YR 4/6) silty clay loam, yellowish red (5YR 5/8) dry; weak coarse subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many very fine tubular pores; common moderately thick and thick continuous clay films on peds and in pores; strongly acid.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. The horizon is 18 to 27 percent clay and 5 to 15 percent concretions 1 to 5 millimeters in diameter.

The B horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or silty clay loam and has 25 to 35 percent clay and as much as 15 percent concretions 1 to 5 millimeters in diameter.

Braun Series

The Braun series consists of moderately deep, well drained soils on mountains. These soils formed in colluvium derived from siltstone. Slope is 5 to 90 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of a Braun silt loam; 100 feet north of Corral Road 192 in the NW1/4SE1/4SE1/4 of sec. 13, T. 4 N., R. 4 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, moss, and woody material.
A1-0 to 4 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 5 percent soft siltstone pebbles 2 to 5 millimeters in diameter; slightly acid; clear smooth boundary.
B1-4 to 9 inches; dark brown (10YR 4/3) 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; 10 percent soft siltstone pebbles; medium acid; gradual wavy boundary.
B2-9 to 18 inches; dark yellowish brown (10YR 4/4) silt loam, very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 20 percent soft siltstone pebbles; medium acid; gradual wavy boundary.
B3-18 to 30 inches; dark yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/3) dry; weak medium subangular blocky structure; slightly hard,

friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 30 percent soft siltstone pebbles; medium acid; gradual wavy boundary.

Cr-30 inches; fractured siltstone.

Depth to soft bedrock is 20 to 40 inches.

The A1 horizon has value of 3 or 4 when moist and 6 or 7 when dry, and it has chroma of 2 or 3 when moist or dry. It is 14 to 18 percent clay and 5 to 15 percent soft siltstone pebbles.

The B1 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 2 or 3 when moist or dry. It is 18 to 27 percent clay, 10 to 25 percent soft siltstone pebbles, and 0 to 15 percent soft siltstone cobbles.

The B2 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 3 or 4 when moist or dry. It is 18 to 22 percent clay, 20 to 40 percent soft siltstone pebbles, and 5 to 20 percent soft siltstone cobbles.

The B3 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 3 or 4 when moist or dry. It is 18 to 22 percent clay, 30 to 50 percent soft siltstone pebbles, and 20 to 30 percent soft siltstone cobbles.

Cascade Series

The Cascade series consists of moderately deep, somewhat poorly drained soils on broad, convex ridgetops and side slopes of hills. These soils formed in silty material. Slope is 3 to 30 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 52 degrees F.

Typical pedon of a Cascade silt loam; about 2 miles west of Scappoose; in the NE1/4 of sec. 15, T. 3 N., R. 2 W., Willamette Meridian.

A11-0 to 6 inches; dark brown (7.5YR 3/2) silt loam, brown (10YR 5/3) dry; strong fine granular structure and very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and few fine, medium, and coarse roots; many very fine irregular pores; 10 percent fine hard concretions; medium acid; clear smooth boundary.

A12-6 to 15 inches; dark brown (7.5YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 10 percent fine hard concretions; medium acid; clear wavy boundary.

B2-15 to 24 inches; dark brown (7.5YR 3/4) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine tubular pores; common fine hard concretions; medium acid; clear wavy boundary.

IIBx1-24 to 36 inches; dark yellowish brown (10YR 4/4) heavy silt loam, light yellowish brown (10YR 6/4) dry; 30 percent light brownish gray (10YR 6/2, dry) and white (10YR 8/1, dry) silt loam tongues with strong brown (7.5YR 5/6, dry) and reddish yellow (7.5YR 6/6, dry) mottles at the margins; weak coarse prismatic structure parting to moderate fine subangular blocky; very hard, very firm, slightly sticky and slightly plastic; brittle; few fine and medium roots; many very fine tubular pores; few fine hard concretions; few fine black stains; strongly acid; clear wavy boundary.

IICx-36 to 60 inches; dark brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) dry; 5 percent light brownish gray (10YR 6/2) tongues with brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles at the margins; massive; very hard, very firm, sticky and plastic; brittle; few very fine roots along fractures; common very fine tubular pores; common moderately thick clay films in pores; common medium and coarse black stains; strongly acid.

The depth to the fragipan ranges from 20 to 30 inches. The umbric epipedon ranges from 10 to 19 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, and it has chroma of 2 or 3 when moist.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or light silty clay loam and has 18 to 30 percent clay and less than 10 percent sand that is coarser than very fine sand.

The underlying fragipan has mottles and tongues in chroma of 2. It ranges from 2 feet to more than 4 feet in thickness. It is silt loam or silty clay loam, firm or very firm, and hard or very hard. Clay films in fractures and pores are few or common and thin or moderately thick. Few basalt rock fragments are at or near the upper boundary of the fragipan.

Caterl Series

The Caterl series consists of deep, well drained soils on side slopes of mountains. These soils formed in colluvium derived from igneous rock and mixed with volcanic ash. Slope is 30 to 60 percent. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F.

Typical pedon of a Caterl gravelly silt loam; 100 feet east of Baker Point Road; in the NW1/4NW1/4SE1/4 of sec. 20, T. 5 N, R. 3 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.

A1-0 to 4 inches; dark reddish brown (5YR 3/2) gravelly silt loam, brown (7.5YR 5/4) dry; weak very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic, weakly smeary; many fine and very fine roots; many very fine irregular pores; 10 percent soft concretions 2 to 5 millimeters in diameter; 18 percent basalt pebbles; slightly acid; clear smooth boundary.
B2-4 to 16 inches; dark reddish brown (5YR 3/3) gravelly silt loam, reddish brown (5YR 5/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common fine and medium roots; many very fine tubular pores; 10 percent soft concretions 2 to 5 millimeters in diameter; 25 percent basalt pebbles; medium acid; gradual wavy boundary.
C1-16 to 41 inches; reddish brown (5YR 4/4) extremely gravelly silt loam, reddish brown (5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; 60 percent basalt pebbles and 10 percent basalt cobbles; medium acid; clear wavy boundary. R-41 inches; fractured basalt.

The solum is 16 to 24 inches thick. Depth to bedrock is 40 to 60 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 3 or 4 when dry. It is 15 to 30 percent pebbles.

The B horizon is gravelly silt loam or gravelly loam. It has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 4 or 5 when dry. It is 15 to 30 percent pebbles and 5 to 10 percent cobbles.

The C horizon is extremely gravelly silt loam or extremely cobbly loam. It has value of 4 or 5 when moist or dry, and it has chroma of 4 to 6 when moist or dry. It is 30 to 60 percent pebbles, 10 to 40 percent cobbles, and 5 to 10 percent stones.

Cloquato Series

The Cloquato series consists of very deep, well drained soils in low, convex areas on flood plains. These soils formed in silty alluvium. Slope is 0 to 3 percent. The average annual precipitation is 45 inches, and the average annual air temperature is 53 degrees F.

Typical pedon of a Cloquato silt loam; 1 mile north of Scappoose along Scappoose Creek; in the SE1/4 of sec. 36, T. 4 N., R. 2 W., Willamette Meridian.

A11-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very 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.
A12-7 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.
B2-13 to 38 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine tubular pores; neutral; gradual smooth boundary.
B3-38 to 52 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine tubular pores; neutral; gradual smooth boundary.
C-52 to 60 inches; brown (10YR 4/3) very fine sandy loam, pale brown (10YR 6/3) dry; massive; soft, friable, nonsticky and slightly plastic; few very fine roots; many fine tubular pores; neutral.

Depth to bedrock is more than 5 feet.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is 20 inches to more than 40 inches thick.

The B horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. It is silt loam or loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 when moist or dry, and chroma of 2 to 4 when moist or dry. It is silt loam, loam, very fine sandy loam, or sandy loam.

Cornelius Series

The Cornelius series consists of moderately deep, moderately well drained soils on ridgetops and side slopes of low, rolling hills. These soils formed in silty material. Slope is 3 to 30 percent. The average annual precipitation is 45 inches, and the average annual air temperature is 53 degrees F.

Typical pedon of a Cornelius silt loam; 3 miles west of St. Helens; in the NW1/4 of sec. 6, T. 4 N., R. 1 W., Willamette Meridian.

A1-0 to 6 inches; dark brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and few medium roots; many very fine irregular pores; many fine hard concretions; medium acid; abrupt smooth boundary.
A3-6 to 12 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine

roots; many very fine tubular pores; common fine hard concretions; medium acid; clear smooth boundary.

B1-12 to 19 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21-19 to 30 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few thin clay films in pores; strongly acid; gradual wavy boundary.

B22t-30 to 38 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; common very fine and fine roots; many very fine tubular pores; few moderately thick clay films on peds and in pores; strongly acid; clear smooth boundary.

Bxt-38 to 60 inches; brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; grayish brown (10YR 5/2) tongues and coatings in fractures; yellowish brown (10YR 5/6) mottles at fracture margins; weak coarse prismatic structure; very hard, very firm, slightly sticky and slightly plastic; brittle; few fine roots; common very fine tubular pores; common moderately thick clay films on peds and in pores; common fine black stains; strongly acid.

The depth to the fragipan ranges from 30 to 40 inches. The profile is more than 60 inches deep to bedrock.

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

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is dominantly silty clay loam and has 27 to 35 percent clay and less than 15 percent sand that is coarser than very fine sand. Few faint mottles in hue of 5YR or 7.5YR and chroma of 3 or 4 are near the boundary of the fragipan in some pedons. Clay films are common to nearly continuous and thin to moderately thick on most peds.

The Bxt horizon has matrix colors similar to those of the horizon above it, but it has faint to prominent mottles in chroma of more than 2 and has tongues in chroma of 2. The horizon is silty clay loam and commonly is 2 feet or more in thickness. It is firm and brittle and has few to many, thin to moderately thick clay films on many peds. It overlies dark reddish brown (2.5YR 3/4) clay in some areas.

Crims Series

The Crims series consists of very deep, very poorly drained soils on flood plains. These soils formed in organic material underlain by silty alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Crims silt loam; about 3 miles northeast of Clatskanie; 400 feet north and 165 feet west of the southeast corner of sec. 28, T. 8 N., R. 4 W., Willamette Meridian.

Ap-0 to 9 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; massive; hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

IIOe1-9 to 20 inches; black (10YR 2/1, broken, rubbed, and pressed) hemic material, very dark gray (10YR 3/1) dry; about 40 percent fibers, 20 percent rubbed; common fine roots; very strongly acid; gradual smooth boundary.

IIOe2-20 to 40 inches; very dark grayish brown (2.5YR 3/2, broken, rubbed, and pressed) hemic material, very dark gray (10YR 3/1) dry; about 80 percent fibers, 20 percent rubbed; very strongly acid; gradual smooth boundary.

IICg-40 to 60 inches; dark gray (5Y 4/1) silt loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard, friable, nonsticky and slightly plastic; very strongly acid.

Depth to silty alluvium is 16 to 40 inches.

The surface mantle of mineral soil material has value of 1 or 2 when moist. Some pedons have mottles in hue of 5YR or 7.5YR, value of 2 or 3 when moist, and chroma of 4 to 6 when moist. The organic material has value of 1 or 2 when moist and chroma of 2 or 3. Fiber content ranges from 10 to 50 percent when not rubbed and from 0 to 20 percent when rubbed.

The subsurface tier is 40 to 90 percent fibers when not rubbed and 20 to 25 percent when rubbed.

The bottom tier is silt loam or silty clay loam that is less than 35 percent clay. It has hue of 10YR to 5Y, value of 3 to 5 when moist, and chroma of 1 or 2. Some pedons have mottles in hue of 7.5YR, value of 4, and chroma of 6. Some pedons have thin layers of muck or fine sand.

Dayton Series

The Dayton series consists of very deep, poorly drained soils on concave terraces. These soils formed in silty alluvium underlain by clayey alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 45

inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Dayton silt loam; 100 feet southwest of road in the NW1/4NE1/4NW1/4 of sec. 25, T. 4 N., R. 2 W., Willamette Meridian.

Ap1-0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few fine prominent strong brown (7.5YR 4/6) mottles; moderate fine granular structure parting to very fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine irregular pores; medium acid; clear smooth boundary.

Ap2-4 to 10 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; common fine prominent strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure parting to moderate fine subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

A2-10 to 12 inches; brown (10YR 5/2) silt loam, light gray (10YR 7/1) dry; few fine faint strong brown (7.5YR 4/6) mottles; few fine black stains; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; medium acid; abrupt wavy boundary.

IIB21t-12 to 29 inches; dark grayish brown (10YR 4/2) clay, grayish brown (2.5Y 5/2) dry; few medium black mottles; strong coarse prismatic structure parting to moderate coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; few moderately thick clay films on peds; medium acid; clear smooth boundary.

IIB3t-29 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many fine prominent strong brown (7.5YR 4/6) mottles; weak coarse subangular blocky structure parting to weak medium subangular blocky; slightly hard, friable, sticky and slightly plastic; few very fine roots; common very fine tubular pores; few moderately thick clay films on peds and common moderately thick clay films in pores; slightly acid; clear smooth boundary.

IIIC-60 to 66 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; many fine prominent strong brown (7.5YR 4/6) mottles; massive; hard, firm, nonsticky and nonplastic; brittle; few very fine roots; few very fine tubular pores; slightly acid.

Depth to clay is 12 to 24 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist, and chroma of 1 or 2.

The A2 horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist, and chroma of 1 or 2. It is silty clay or clay. It has 40 to 60 percent clay.

The C horizon has hue of 10YR, 2.5Y, or 5Y. It is sandy loam, silt loam, or silty clay loam.

Delena Series

The Delena series consists of moderately deep, poorly drained soils in concave areas on low rolling hills. These soils formed in silty material. Slope is 3 to 12 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 52 degrees F.

Typical pedon of a Delena silt loam; 100 feet west of road; in the NE1/4NE1/4NE1/4 of sec. 33, T. 6 N., R. 2 W.; Willamette Meridian.

A11-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; common fine hard concretions; medium acid; clear smooth boundary.

A12-7 to 15 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; common fine concretions; medium acid; clear smooth . boundary.

B1-15 to 23 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common fine prominent brown (7.5YR 4/4) and strong brown (7.5YR 4/6) mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

IIB2x-23 to 33 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/1) dry; many fine prominent brown (7.5YR 4/4) and yellowish red (5YR 4/6) mottles; weak coarse prismatic parting to moderate medium subangular blocky; very hard, very firm, slightly sticky and slightly plastic; brittle; few fine and medium roots along fractures; common very fine tubular pores; common moderately thick clay films in pores, in channels, and on some ped faces; strongly acid; clear smooth boundary.

IIB3x-33 to 60 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/1) dry; many fine prominent strong brown (7.5YR 4/6) mottles; weak

coarse prismatic structure parting to moderate medium blocky; very hard, very firm, slightly sticky and slightly plastic; brittle; few fine and medium roots along fractures; common very fine tubular pores; moderately thick clay films in pores and on some ped faces; strongly acid.

Depth to the fragipan is 20 to 30 inches.

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

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 when moist and 1 or 2 when dry. Mottles are distinct or prominent. Texture of the horizon commonly is silty clay loam, but it includes heavy silt loam in the upper part in some pedons.

The Bx horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. The coatings on peds and tongues have the lower chroma and yellower hue. The Bx horizon is firm or very firm and commonly is brittle. It has few to common, thin to moderately thick clay films in pores and on ped faces.

Dowde Series

The Dowde series consists of deep, well drained soils on steep side slopes of mountains. These soils formed in loess mixed with colluvium derived from igneous rock. Slope is 30 to 60 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 47 degrees F.

Typical pedon of a Dowde silt loam; 100 feet east of the North Fork Scappoose Creek-Quarry Road; in the SE1/4NE1/4NW1/4 of sec. 28, T. 4 N., R. 2 W., Willamette Meridian.

O1-3 inches to 0; leaves, twigs, moss, and woody material.

A1-0 to 5 inches; dark reddish brown (5YR 3/3) silt loam, brown (7.5YR 5/4) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots and few medium and coarse roots; many very fine irregular pores; 10 percent very fine pebbles; slightly acid; clear smooth boundary.

B21-5 to 19 inches; reddish brown (5YR 4/3) silt loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots and few medium roots; many very fine tubular pores; 5 percent very fine pebbles; medium acid; gradual wavy boundary.

B22-19 to 37 inches; reddish brown (5YR 4/3) silt loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots and few medium roots; many very fine tubular pores; 3 percent very fine pebbles; medium acid; gradual wavy boundary.

B23-37 to 54 inches; reddish brown (5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; many very fine tubular pores; 5 percent very fine pebbles and 2 percent basalt cobbles; very strongly acid; gradual wavy boundary.

C-54 to 60 inches; reddish brown (5YR 4/4) gravelly silty clay loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, sticky and plastic; 20 percent pebbles and 10 percent basalt cobbles; very strongly acid.

The solum ranges from 45 to 67 inches in thickness. Depth to bedrock is more than 60 inches.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. It is 0 to 10 percent very fine pebbles.

The B horizon has hue of 7.5YR or 5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is 0 to 10 percent very fine pebbles.

The C horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 4 to 6 when moist or dry. It is 5 to 30 percent pebbles and 0 to 15 percent cobbles.

Dystrochrepts

Dystrochrepts are well drained to somewhat poorly drained soils on fans or valley sides. These soils formed in alluvium. Slope is 3 to 15 percent. The average annual precipitation is about 60 inches, and the average annual temperature is about 50 degrees F.

Reference profile of a Dystrochrept; 250 feet south of old U.S. Highway 30; in the SW1/4NE1/4 of sec. 10, T. 7 N., R. 5 W., Willamette Meridian.

A1-0 to 5 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, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 5 percent pebbles; medium acid; abrupt smooth boundary.

A3-5 to 9 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; 5 percent pebbles; medium acid; clear smooth boundary.

B1-9 to 16 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; many very fine roots; many very fine tubular pores; 10 percent pebbles; medium acid; clear smooth boundary.

B21-16 to 28 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; 15 percent pebbles; medium acid; clear smooth boundary.

B22-28 to 39 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common distinct dark grayish brown and strong brown mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; 5 percent pebbles; strongly acid; gradual wavy boundary.

C-39 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common distinct dark grayish brown, strong brown, and reddish brown mottles; massive; hard, firm, sticky and plastic; few very fine roots; many very fine tubular pores; 10 percent pebbles; strongly acid.

Depth to bedrock is more than 60 inches. The solum is silt loam, loam, clay loam, or sandy loam. It is 0 to 50 percent rock fragments throughout. Reaction is slightly acid to strongly acid throughout the profile. Gravel and cobbles are soft to very hard.

Eilertsen Series

The Eilertsen series consists of deep, well drained soils on low terraces. These soils formed in silty alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 50 degrees F.

Typical pedon of an Eilertsen silt loam; about 100 yards west of logging road in the SE1/4SW1/4NW1/4 of sec. 23, T. 5 N., R. 4 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.

A11-0 to 7 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

A12-7 to 17 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; strongly acid; clear wavy boundary.

B21t-17 to 25 inches; dark brown (1 OYR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very dark grayish brown (10YR 3/2) clay films on peds and in pores; many very fine tubular pores; common very fine roots; very strongly acid; gradual wavy boundary.

B22t-25 to 37 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very dark grayish brown (10YR 3/2) clay films on peds and in pores; common fine roots; many very fine tubular pores; very strongly acid; clear smooth boundary.

IIB3-37 to 49 inches; brown (10YR 4/3) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very dark grayish brown (10YR 3/2) clay films on peds and in pores; few fine roots; many very fine tubular pores; very strongly acid; gradual wavy boundary.

IIC-49 to 60 inches; brown (10YR 4/3) fine sandy loam, light yellowish brown (10YR 6/4) dry; common fine distinct grayish brown (10YR 5/2) and dark brown (7.5YR 4/4) mottles; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine roots; many very fine tubular pores; very strongly acid.

Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is 10 to 20 inches thick. Clay content is 12 to 20 percent.

The B horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. Distinct grayish brown and dark brown mottles are below a depth of 40 inches in some pedons. Clay films are few to common and are on peds and in pores. Clay content is 18 to 35 percent.

The C horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when dry or moist. Mottles are distinct strong brown and grayish brown. The horizon is fine sandy loam, loam, or silt loam. Clay content is 10 to 20 percent.

Glohm Series

The Glohm series consists of moderately deep, moderately well drained soils in convex areas on uplands and on ridgetops on marine terraces. These soils formed in silty material over mixed old alluvium and residuum. Slope is 3 to 30 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a Glohm silt loam (fig. 11); 50 feet west of Glohm Road; in the SW1/4NE1/4SE1/4 of sec. 15, T. 4 N., R. 4 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, moss, and woody material.

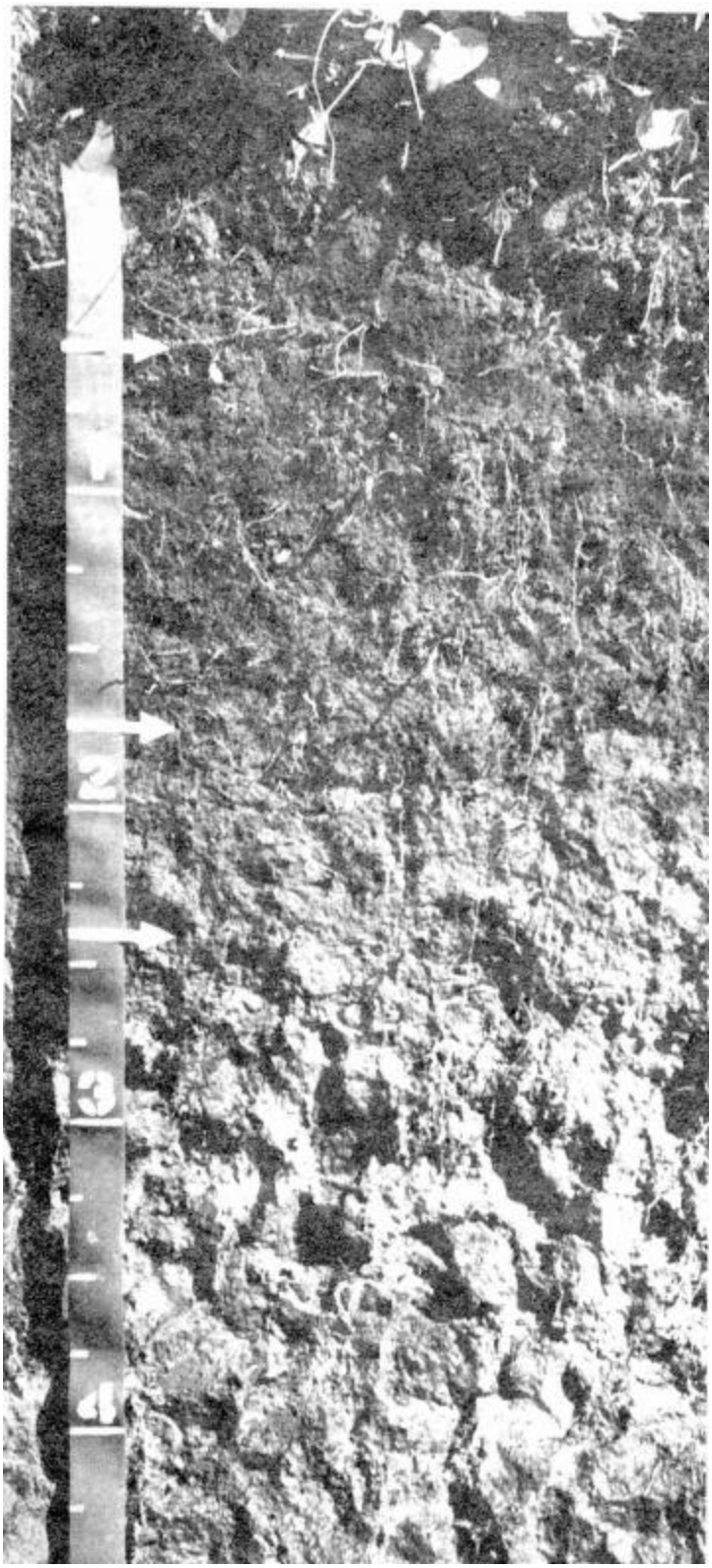


Figure 11. -Profile of Glohm silt loam, 3 to 30 percent slopes. A fragipan is at a depth of 29 inches.

A11-0 to 2 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; 5 percent pebbles 2 to 5 millimeters in diameter; medium acid; abrupt smooth boundary.

A12-2 to 5 inches; brown (7.5YR 4/3) silt loam, light brown (7.5YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent pebbles 2 to 3 millimeters in diameter; medium acid; clear smooth boundary.

B1-5 to 12 inches; brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent pebbles 2 to 3 millimeters in diameter; medium acid; clear wavy boundary.

B21-12 to 18 inches; brown (7.5YR 4/3) silt loam, light brown (7.5YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 5 percent pebbles 2 to 3 millimeters in diameter; medium acid; clear wavy boundary.

B22-18 to 26 inches; brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B23-26 to 36 inches; brown (7.5YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine gray (10YR 6/2) and brown (10YR 5/6) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; few thin clay films in pores; strongly acid; clear wavy boundary.

IIBx-36 to 60 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common gray (10YR 6/2) and brown (10YR 5/6) mottles; massive; very hard, very firm, sticky and plastic; brittle; few fine roots in fractures; few fine and medium pores; few to common thin clay films in pores and on fracture faces; few black stains on fracture faces; very strongly acid.

The depth to the fragipan ranges from 20 to 40 inches. The profile is more than 60 inches deep to bedrock. The ochric epipedon is 4 to 9 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist and 3 or 4 when dry. The clay content

is 15 to 20 percent. The horizon is 5 to 15 percent pebbles 2 to 5 millimeters in diameter.

The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 moist. It is silt loam or silty clay loam that is 20 to 30 percent clay. The horizon is 0 to 10 percent pebbles 2 to 3 millimeters in diameter. It has few distinct mottles in hue of 10YR, value of 5 or 6, and chroma of 2 or 6.

The Bx horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or silty clay loam and is 25 to 35 percent clay. It has distinct and prominent mottles in chroma of 2. Clay films on fractures are common or continuous and thin.

Goble Series

The Goble series consists of moderately deep, moderately well drained soils on long, convex side slopes and ridgetops on rolling hills. These soils formed in silty material and small amounts of volcanic ash. Slope is 3 to 30 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a Goble silt loam; about 7 miles north of junction of Walker Road and Beaver Home Road; in the NW1/4 of sec. 16, T. 6 N., R. 2 W., Willamette Meridian.

A1-0 to 7 inches; dark brown (7.5YR 3/2) silt loam, brown (10YR 5/3) dry; strong very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; few 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 very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; few fine concretions; medium acid; clear smooth boundary.

B1-14 to 26 inches; dark brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; many very fine tubular pores; few fine concretions; strongly acid; clear smooth boundary.

B2-26 to 38 inches; dark brown (7.5YR 4/4) heavy silt loam, light brown (7.5YR 6/4) dry; moderate fine subangular blocky structure; slightly hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; strongly acid; abrupt smooth boundary.

IIBx-38 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 4/3), strong brown (7.5YR 5/6), and yellowish brown (10YR 5/4) mottles and light gray (10YR 7/1) tongues in fracture planes; common black stains; weak coarse prismatic structure parting to weak medium subangular blocky; very hard, very firm, sticky and plastic; brittle; few fine roots along ped faces; common very fine tubular pores; common thin clay films in fractures and on prism faces; very strongly acid.

The depth to the fragipan ranges from 30 to 45 inches. The profile is more than 60 inches deep to bedrock. The umbric epipedon is 10 to 20 inches thick.

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

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4. The horizon typically is silty clay loam, but it is silt loam in the upper part. None to few, faint mottles in chroma of 3 or 4 and hue of 5YR are near the boundary with the fragipan in some pedons.

The Bx horizon has matrix colors similar to those of the horizon above it, but it has distinct and prominent mottles in chroma of 2. The horizon is hard, very firm, and brittle. Clay films on prism faces and fractures are common or continuous and thin. The fragipan commonly is more than 1 foot thick and overlies old alluvium or loess and residuum of mixed origin.

Hapludalfs

Hapludalfs are well drained and moderately well drained soils on terraces. These soils formed in old alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F.

Reference profile of a Hapludalf; 300 feet west of Vernonia Airport Road; in the NW1/4NW1/4 sec. 7, T. 4 N., R. 3 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.

A11-0 to 5 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; strong very fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

A3-5 to 9 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; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

B1t-9 to 15 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common thin clay films on peds and in

pores; many very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
B21t-15 to 24 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many thin clay films on peds and in pores; many very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.
B22t-24 to 37 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; common thin clay films on peds and in pores; common very fine roots; many very fine tubular pores; strongly acid; gradual wavy boundary.
C-37 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common fine distinct dark grayish brown and strong brown mottles; massive; hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; strongly acid.

Depth to bedrock is more than 60 inches.

The A horizon is silt loam, loam, or sandy loam. Hue is 7.5YR, 10YR, or 2.5Y.

The B horizon is silt loam, clay loam, silty clay loam, or silty clay. Rock fragment content ranges from 0 to 45 percent.

Hembre Series

The Hembre series consists of deep, well drained soils on convex upland side slopes and ridgetops. These soils formed in colluvium and residuum derived from basalt. Slope is 3 to 60 percent. The average annual precipitation is 70 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a Hembre silt loam; 1,500 feet west of Rock Creek bridge and 200 feet south of Rock Creek Road; in the NW1/4NW1/4NE1/4 of sec. 7, T. 4 N., R. 5 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, bark, and woody material.
A11-0 to 8 inches; dark reddish brown (5YR 3/2) silt loam, dark brown (7.5YR 4/3) dry; strong very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots; many very fine irregular pores; few fine concretions; 5 percent pebbles; very strongly acid; clear smooth boundary.
A12-8 to 16 inches; dark reddish brown (5YR 3/3) silt loam, brown (7.5YR 5/4) dry; strong fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many fine and very fine roots; many fine and very fine irregular pores; 5 percent pebbles; very strongly acid; clear smooth boundary.
B1-16 to 26 inches; dark brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; strong very fine subangular blocky structure; hard, friable, nonsticky and slightly plastic; common fine roots; many fine irregular pores; 5 percent pebbles; very strongly acid; clear smooth boundary.
B21-26 to 38 inches; strong brown (7.5YR 4/6) silt loam, brownish yellow (10YR 6/6) dry; moderate fine subangular blocky structure; hard, friable, nonsticky and slightly plastic; common fine roots; many fine and very fine tubular pores; 5 percent pebbles; very strongly acid; gradual smooth boundary.
B22-38 to 48 inches; dark yellowish brown (10YR 4/4) gravelly silty clay loam, light yellowish brown (10YR 6/4) dry; weak very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; 25 percent pebbles; very strongly acid; gradual wavy boundary.
R-48 inches; partially weathered basalt.

Thickness of the solum and depth to bedrock are 40 to 60 inches.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. It is 0 to 15 percent pebbles and cobbles.

The B horizon has value of 3 or 4 when moist and chroma of 4 to 6. It is silty clay loam or heavy silt loam and is 0 to 35 percent pebbles.

Kenusky Series

The Kenusky series consists of very deep, poorly drained soils in concave areas on mountain ridgetops. These soils formed in clayey material. Slope is 0 to 15 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a Kenusky silty clay loam; 100 feet east of road; in the SE1/4SE1/4SE1/4 of sec. 16, T. 5 N., R. 4 W.

O-1 inch to 0; leaves, twigs, moss, and woody material.
A11-0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; strong very fine subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine roots; many fine irregular pores; very strongly acid; abrupt smooth boundary.
A12-8 to 13 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; common fine dark yellowish brown (10YR 4/6) mottles; strong fine subangular blocky structure; very hard, firm, very sticky and very plastic; common very fine and fine roots; many fine tubular pores; very strongly acid; clear smooth boundary.

B21t-13 to 19 inches; dark gray (10YR 4/1) silty clay, gray (10YR 6/1) dry; common fine distinct dark yellowish brown (10YR 4/6) mottles; strong coarse subangular blocky structure; very hard, firm, very sticky and very plastic; common fine and very fine roots; many very fine tubular pores; very strongly acid; few moderately thick clay films in pores; clear smooth boundary.
B22t-19 to 44 inches; dark gray (10YR 4/1) clay, grayish brown (2.5Y 5/2) dry; common fine distinct dark yellowish brown (10YR 4/6) mottles; weak coarse subangular blocky structure; extremely hard, very firm, extremely sticky and extremely plastic; few fine roots; common very fine tubular pores; very strongly acid; common moderately thick clay films on peds and in pores; clear smooth boundary.
C-44 to 60 inches; grayish brown (10YR 5/2) clay, light gray (2.5Y 7/2) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; extremely hard, very firm, extremely sticky and extremely plastic; few fine tubular pores; few fine and medium dark grayish brown (10YR 4/2) clay films on peds and few moderately thick clay films in pores; very strongly acid.

The A horizon has value of 2 or 3 when moist or dry, and it has chroma of 1 or 2 when moist or dry.

The B horizon has hue of 10YR or 2.5YR when dry, value of 4 or 5 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. Clay content is 50 to 70 percent. Mottles are distinct dark yellowish brown or strong brown.

The C horizon has hue of 10YR or 2.5Y when dry, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. Mottles are distinct strong brown or dark yellowish brown. Clay content is 50 to 70 percent.

Klickitat Series

The Klickitat series consists of deep, well drained soils on convex side slopes and ridgetops on mountains. These soils formed in colluvium and residuum derived from basalt. Slope is 3 to 60 percent. The average annual precipitation is about 70 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a Klickitat gravelly loam; 0.5 mile west of Rock Creek bridge and 100 feet south of Rock Creek Road; in the SW1/4NE1/4NW1/4 of sec. 7, T. 4 N., R. 5 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, needles, and woody material.
A11-0 to 5 inches; dark reddish brown (5YR 3/2) gravelly loam, dark reddish gray (5YR 4/2) dry; strong very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots; many fine and very fine irregular pores; 5 percent stones, 5 percent cobbles, and 20 percent pebbles; slightly acid; abrupt smooth boundary.
A12-5 to 12 inches; dark reddish brown (5YR 3/3) gravelly loam, reddish brown (5YR 5/2) dry; strong very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots; many fine and very fine irregular pores; 5 percent stones, 5 percent cobbles, and 20 percent pebbles; strongly acid; clear smooth boundary.
B2-12 to 37 inches; dark brown (7.5YR 3/4) very gravelly clay loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and plastic; many fine and very fine roots; many very fine tubular pores; 5 percent stones, 15 percent cobbles, and 25 percent pebbles; strongly acid; clear smooth boundary.
C-37 to 58 inches; dark brown (7.5YR 4/4) very cobbly loam, brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few fine and very fine roots; many very fine tubular pores; 15 percent stones, 30 percent cobbles, and 20 percent pebbles; strongly acid; abrupt wavy boundary.
R-58 inches; basalt.

The solum is 20 to 40 inches thick. Depth to bedrock is 40 to 60 inches.

The A horizon has hue of 7.5YR or 5YR, and it has value of 2 or 3 when moist and 4 or 5 when dry. Chroma of less than 3.5 when moist extends to a depth of at least 10 inches. The horizon is clay loam or loam.

The B horizon has value of 3 or 4 when moist and 4 to 6 when dry. The upper part of the horizon has chroma of 3 or 4 when dry and 5 or 6 when moist, and the lower part has chroma of 4 to 6 when dry. The B horizon is dominantly clay loam but ranges to heavy loam or silty clay loam. It is 35 to 70 percent cobbles and pebbles.

The C horizon has hue of 7.5YR or 5YR and value of 5 or 6 when dry.

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 alluvium. Slope is 0 to 8 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Latourell silt loam; in the NE1/4SW1/4NW1/4 of sec. 21, T. 5 N., R. 1 W., Willamette Meridian.

Ap1-0 to 4 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; many very fine and fine roots; many

very fine irregular pores; strongly acid; abrupt smooth boundary.

Ap2-4 to 9 inches; dark brown (10YR 3/3) 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; strongly acid; abrupt smooth boundary.

B1t-9 to 15 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine tubular pores; few moderately thick clay films in pores; medium acid; gradual wavy boundary.

B21t-15 to 23 inches; brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; common thin clay films on peds; medium acid; clear smooth boundary.

B22t-23 to 31 inches; brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; many thick clay films in pores and on peds; medium acid; clear smooth boundary.

B31t-31 to 45 inches; dark yellowish brown (10YR 3/4) loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; hard, firm, nonsticky and slightly plastic; brittle; few very fine roots; common very fine tubular pores; common moderately thick clay films in pores and on peds; medium acid; clear smooth boundary.

B32t-45 to 60 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; few grayish brown (10YR 5/2) and brown (10YR 5/3) mottles; weak coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; few fine roots; common very fine tubular pores; common moderately thick clay films in pores and on peds; medium acid.

The solum is 30 to 60 inches thick.

The A horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. It is loam to silt loam.

The B horizon has value of 4 or 5 when moist and 6 when dry, and it has chroma of 3 or 4 when moist or dry. It is 18 to 22 percent clay. It has few to common, thin to moderately thick clay films.

The C horizon is 25 to 60 percent pebbles and has a few embedded stones or cobbles.

Locoda Series

The Locoda series consists of deep, very poorly drained soils in plane to concave areas on flood plains of the Columbia River. These soils formed in recent silty alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 52 degrees F.

Typical pedon of a Locoda silt loam; about 5 miles north of Clatskanie; 50 feet south of Dike Road and 0.25 mile west-southwest of gate to Portland General Electric Beaver Power Plant; in the NW1/4NW1/4 of sec. 21, T. 8 N., R. 4 W., Willamette Meridian.

Ap1-0 to 4 inches; dark grayish brown (10YR 4/2) silt loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and many very fine roots; common fine and very fine irregular pores and many medium vertical pores; very strongly acid; clear smooth boundary.

Ap2-4 to 10 inches; gray (5YR 5/1) silt loam; common fine prominent dark yellowish brown (10YR 4/6) mottles; weak fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine roots; common very fine and fine irregular pores and many vertical pores; very strongly acid; gradual smooth boundary.

C1g-10 to 22 inches; gray (5Y 5/1) silty clay loam; common fine and medium prominent strong brown (7.5YR 4/6) mottles; massive; hard, firm, sticky and plastic; common very fine roots; few fine and very fine irregular pores; very strongly acid; gradual smooth boundary.

C2g-22 to 26 inches; gray (5Y 5/1) silty clay loam; common fine and medium prominent dark yellowish brown (10YR 3/6) mottles; massive; hard, firm, sticky and plastic; few very fine roots; few very fine irregular pores; common lenses of very dark brown (10YR 2/2) organic material; very strongly acid; gradual smooth boundary.

C3g-26 to 40 inches; gray (5Y 5/1) silt loam; few fine prominent strong brown (7.5YR 4/6) mottles; massive; hard, firm, sticky and plastic; few very fine roots; few very fine irregular pores; very strongly acid.

The 10- to -40-inch control section exhibits an irregular decrease in organic matter as depth increases.

The A horizon is 6 to 10 inches thick. It has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. Common, distinct or prominent mottles are throughout the horizon.

The C horizon has hue of 2.5Y to 5B, value of 4 or 5, and chroma of 0 or 1. On exposure to air, the lower part in some pedons may change from hue of 5B to 5Y or from 5Y to 2.5Y. The C horizon is 18 to 35 percent clay. It typically has lenses of decomposed organic material 2 to 5 millimeters thick.

Mayger Series

The Mayger series consists of deep, somewhat poorly drained soils on smooth, broad ridgetops and side slopes of rolling hills. These soils formed in residuum and colluvium derived dominantly from shale. Slope is 3 to 30 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of a Mayger silt loam; 200 feet west of Cootes Mainline road; in the NE1/4SE1/4NE1/4 of sec. 29, T. 5 N., R. 4 W., Willamette Meridian.

O-1 inch to 0; needles, twigs, moss, and woody material.

A11-0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

A12-5 to 11 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; strong very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21t-11 to 17 inches; dark yellowish brown (1 OYR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; common moderately thick clay films on peds; strongly acid; clear smooth boundary.

B22t-17 to 30 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; common distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common medium tubular pores; many moderately thick clay films on peds; very strongly acid; gradual smooth boundary.

B3t-30 to 38 inches; grayish brown (2.5Y 5/2) silty clay, light olive brown (2.5Y 5/3) dry; many distinct dark brown (7.5YR 4/4) mottles; weak coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; common medium pores; many thick clay films; very strongly acid; abrupt smooth boundary. .

IIC-38 to 60 inches; grayish brown (2.5YR 5/2) clay, light olive brown (2.5Y 5/3) dry; many distinct strong brown (7.5YR 5/6, 5/8) mottles; massive; extremely hard, very firm, very sticky and very plastic; few fine roots; few medium tubular pores; many thick olive brown (2.5Y 4/6) clay films on fractures and in pores; very strongly acid.

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

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist, and chroma of 2 or 3 when moist or dry. Clay content is 30 to 50 percent. Mottles are distinct dark brown or strong brown.

The C horizon has hue of 2.5Y or neutral, value of 5 or 6 when moist or dry, and chroma of 2 or 3. Mottles are distinct strong brown or brown. Clay content is 50 to 70 percent.

McBee Series

The McBee series consists of very deep, moderately well drained soils on low flood plains. These soils formed in mixed alluvium. Slope is 0 to 1 percent. The average annual precipitation is 45 inches, and the average annual air temperature is 53 degrees F.

Typical pedon of a McBee silt loam; 250 feet south of Dutch Canyon Road; in the SW1/4NE1/4NE1/4 of sec. 16, T. 3 N., R. 2 W., Willamette Meridian.

Ap1-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

A12-8 to 17 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; few very dark grayish brown (10YR 3/2) stains on peds; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

A13-17 to 26 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; few very dark grayish brown (10YR 3/2) stains on peds; slightly hard, friable, sticky and slightly plastic; common very fine roots; many fine and very fine tubular pores; slightly acid; clear smooth boundary.

B21-26 to 36 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; few dark brown (10YR 3/3) stains on peds; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine and very fine tubular pores; slightly acid; clear wavy boundary.

B22-36 to 42 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; many dark brown (10YR 3/3) stains on all peds; many fine distinct dark grayish brown (10YR 4/2) and strong brown (7.5YR 4/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; slightly acid; clear wavy boundary.

C1-42 to 60 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; many fine distinct dark grayish brown (10YR 4/2), strong brown (7.5YR 4/6), and dark brown (7.5YR 4/4) mottles; massive; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few fine black stains; slightly acid.

The 10- to 40-inch control section is less than 35 percent clay. The control section commonly has no rock fragments, but the content of rock fragments is as much as 20 percent below a depth of 35 inches and as much as 50 percent below a depth of 40 inches. The mollic epipedon is 20 to 40 inches thick. Mottles in chroma of 2 or less are above a depth of 30 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is silt loam or silty clay loam. It is less than 15 percent sand that is coarser than very fine sand, and it averages less than 35 percent clay.

The C horizon is silt loam or clay loam.

McNulty Series

The McNulty series consists of very deep, well drained soils on flood plains. These soils formed in recent alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a McNulty silt loam; in the NW1/4SW1/4NE1/4 of sec. 23, T. 5 N., R. 4 W., Willamette Meridian.

Ap1-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

Ap2-6 to 9 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21-9 to 23 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; medium acid; clear wavy boundary.

B22-23 to 32 inches; dark brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; medium acid; clear wavy boundary.

IIC1-32 to 40 inches; dark yellowish brown (10YR 4/4) sandy loam, yellowish brown (10YR 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; common fine roots; many very fine tubular pores; medium acid; clear wavy boundary.

IIIC2-40 to 60 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; medium acid; clear wavy boundary.

IVC3-60 to 70 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; few fine roots; many very fine tubular pores; medium acid.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. Clay content is 12 to 18 percent.

The B horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 3 or 4 when moist or dry. Clay content is 12 to 18 percent.

The C horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. Clay content is 8 to 15 percent.

Moag Series

The Moag series consists of deep, very poorly drained soils on flood plains. These soils formed in recent clayey alluvium. Slope is 0 to 2 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is 53 degrees F.

Typical pedon of a Moag silty clay loam; about 1,000 feet south of Multnomah Channel; in the NE1/4NE1/4SW1/4 of sec. 9, T. 3 N., R. 1 W., Willamette Meridian.

A11-0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam, light brownish gray (10YR 6/2) dry; few fine prominent mottles; moderate fine granular structure; hard, firm, sticky and plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

A12-5 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, light gray (10YR 7/2) dry; few fine prominent mottles; moderate fine granular structure; hard, firm, sticky and plastic; many very fine roots; common very fine tubular pores; medium acid; abrupt smooth boundary.

B21-10 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine brown mottles when dry; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, very sticky

and very plastic; few very fine roots; many very fine and fine tubular pores; medium acid; gradual wavy boundary.

B22-25 to 34 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (2.5Y 7/2) dry; many fine distinct dark gray, yellowish brown, and yellowish red mottles; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; few fine roots; common very fine tubular pores; medium acid; abrupt smooth boundary.

C1-34 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (10YR 7/1) dry; common thick dark gray coatings and many thick yellowish red coatings in pores; hard, firm, sticky and plastic; medium acid.

The A horizon has value of 3 or 4 when moist and 6 or 7 when dry, and it has chroma of 1 or 2 when moist or dry. It is silt loam or silty clay loam.

The B horizon has value of 3 or 4 when moist and 6 or 7 when dry, and it has chroma of 1 or 2 when moist or dry. It has distinct or prominent mottles. It is silty clay or clay and is 40 to 50 percent clay. Thin lenses of peat or loamy material that has value of 2 or 3 and chroma of 1 are common.

The C horizon has hue of 10YR, 2.5Y, or neutral, value of 4 or 5 when moist, and chroma of 0 to 2 when moist or dry. It is stratified silty clay, silt loam, and sandy loam.

Multnomah Series

The Multnomah series consists of deep, well drained soils on old terraces. These soils formed in gravelly or cobbly alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Multnomah loam (fig. 12); about 100 feet east of pebbles road and 0.25 mile west of U.S. Highway 30; in the SW1/4SW1/4 of sec. 8, T. 5 N., R. 1 W., Willamette Meridian.

Ap-0 to 8 inches;, dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; moderate fine and very fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; 15 percent pebbles; medium acid; abrupt smooth boundary.

B21-8 to 18 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; moderate fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; 15 percent pebbles; medium acid; gradual smooth boundary.

B22-18 to 27 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic, common very fine roots, many very fine

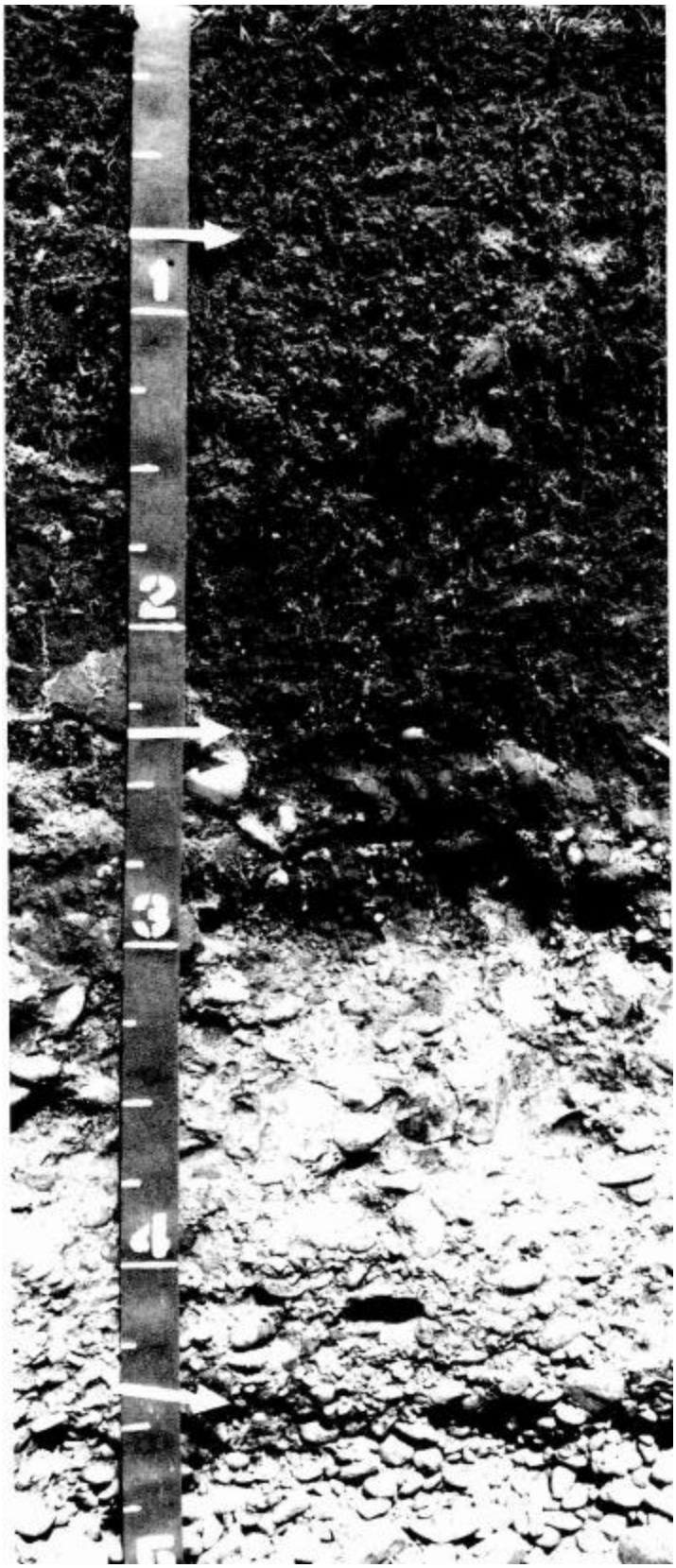


Figure 12. -Profile of Multnomah loam, 0 to 3 percent slopes. The soil is underlain by gravelly alluvium.

tubular pores; 15 percent pebbles; medium acid; abrupt smooth boundary.

IIC1-27 to 34 inches; dark brown (7.5YR 3/4) gravelly loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; many very fine irregular pores; 15 percent pebbles and 5 percent cobbles; medium acid; clear smooth boundary.

IIC2-34 to 60 inches; dark brown (7.5YR 3/4) very gravelly coarse sand, brown (7.5YR 5/4) dry; massive; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; 65 percent pebbles and 10 percent cobbles; medium acid.

The solum is 20 to 30 inches thick, and the depth to contrasting material is 24 to 40 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It ranges from silt loam to gravelly silt loam. Content of rock fragments is 0 to 30 percent, of which 0 to 25 percent is pebbles.

The B horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It ranges from silt loam to gravelly loam. Content of rock fragments is 15 to 35 percent, of which 15 to 30 percent is pebbles and 0 to 5 percent is cobbles.

The C horizon is gravelly silt loam to very gravelly or cobbly loamy sand. Content of rock fragments is 20 to 75 percent, of which 15 to 60 percent is pebbles and 5 to 10 percent is cobbles.

Multnomah Variant

The Multnomah Variant consists of deep, well drained soils on terraces. These soils formed in gravelly or cobbly alluvium. Slope is 0 to 8 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 52 degrees F.

Typical pedon of a Multnomah Variant; about 100 feet east of county road; in the SE1/4NW1/4SE1/4 of sec. 34, T. 8 N., R. 4 W., Willamette Meridian.

A11 -0 to 10 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; 5 percent pebbles; medium acid; abrupt wavy boundary.

A12-10 to 18 inches; dark brown (10YR 3/3) gravelly loam, brown (10YR 5/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many fine irregular pores; 5 percent cobbles and 15 percent pebbles; medium acid; clear smooth boundary.

B21-18 to 32 inches; brown (10YR 4/3) gravelly loam, yellowish brown (10YR 5/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many fine tubular pores; 5 percent cobbles and 20 percent pebbles; medium acid; gradual wavy boundary.

B22-32 to 38 inches; dark yellowish brown (10YR 4/4) gravelly loam, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; many fine tubular pores; 5 percent cobbles and 25 percent pebbles; medium acid; gradual wavy boundary.

C-38 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand, brownish yellow (10YR 6/6) dry; single grain; loose, nonsticky and nonplastic; few fine roots; many very fine tubular pores; 45 percent pebbles and 5 percent cobbles; medium acid.

Depth to bedrock is 60 inches or more. The solum is 30 to 50 inches thick.

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

The B horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist and 5 or 6 when dry. It is gravelly loam or gravelly silt loam. Content of rock fragments ranges from 15 to 35 percent.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 or 5 when moist or 5 or 6 when dry. Content of rock fragments ranges from 35 to 70 percent. The horizon is sandy or sandy-skeletal.

The C horizon has hue of 10YR or 7.5YR.

Murnen Series

The Murnen series consists of deep, well drained soils on ridgetops and side slopes of mountains. These soils formed in material derived from igneous rock and mixed with volcanic ash. Slope is 3 to 60 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 45 degrees F.

Typical pedon of a Murnen silt loam; 200 feet north of Clatskanie mountain road; in the SW1/4NE1/4 of sec. 27, T. 7 N., R. 5 W., Willamette Meridian.

O1-2 inches to 0; decaying needles, twigs, leaves, and woody material.

A11-0 to 6 inches; dark reddish brown (5YR 3/2) silt loam, brown (5YR 4/2) dry; strong very fine granular structure; slightly hard, friable, nonsticky and nonplastic, weakly smeary; many fine and very fine roots; many very fine irregular pores; few basalt pebbles; very strongly acid; clear smooth boundary.

A12-6 to 13 inches; dark reddish brown (5YR 3/2) silt loam, brown (5YR 4/2) dry; strong fine and very fine granular structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine and very fine roots; many very fine irregular pores; few basalt pebbles; very strongly acid; clear smooth boundary.

B21-13 to 27 inches; reddish brown (5YR 4/4) silt loam, brown (7.5YR 5/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine and very fine roots; many very fine irregular pores; few basalt pebbles; very strongly acid; gradual wavy boundary.

B22-27 to 41 inches; dark brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; weak very fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; many very fine tubular pores; few basalt pebbles; very strongly acid; gradual wavy boundary.

C-41 to 46 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; 60 percent basalt pebbles; extremely acid; gradual wavy boundary. R-46 inches; fractured basalt.

Depth to bedrock is 40 to 60 inches. The profile is very strongly acid or extremely acid.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 when moist and 2 to 4 when dry. It is as much as 10 percent basalt pebbles.

The B horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 4 to 6 when moist or dry. It is as much as 15 percent basalt pebbles.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist or dry, and chroma of 3 or 4 when moist and 4 to 6 when dry. It is 35 to 70 percent basalt pebbles.

Natal Series

The Natal series consists of deep, poorly drained soils on low terraces of mountain streams. These soils formed in old alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 50 degrees F.

Typical pedon of a Natal silty clay loam; 400 yards east of U.S. Highway 47 and 80 yards south of pebble road; in the center of sec. 34, T. 5 N., R. 4 W., Willamette Meridian.

Ap-0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; common fine prominent brown (7.5YR 4/4) mottles; weak very fine subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine and common fine roots; many very fine and common fine tubular pores and common medium irregular pores; medium acid; abrupt smooth boundary.

B21t-9 to 16 inches; very dark grayish brown (2.5Y 3/2) silty clay, gray (10YR 6/1) dry; common fine prominent brown (7.5YR 4/4) mottles, strong brown (7.5YR 5/6) dry, and few fine prominent yellowish red (5YR 5/8) mottles; strong fine subangular blocky structure; hard, firm, sticky and very plastic; many very fine roots; many very fine and few fine tubular pores and common medium irregular pores; medium acid; clear smooth boundary.

B22t-16 to 23 inches; very dark grayish brown (2.5Y 3/2) silty clay, gray (10YR 6/1) dry; common fine prominent brown (7.5YR 4/4) mottles, strong brown (7.5YR 5/6) dry; strong medium angular blocky structure; very hard, firm, sticky and very plastic; few thin clay films on faces of peds and in pores; common very fine roots; common very fine and fine tubular pores and common medium irregular pores; strongly acid; clear smooth boundary.

B23t-23 to 40 inches; dark grayish brown (2.5Y 4/2) silty clay,, gray (10YR 6/1) dry; common fine prominent brown (7.5YR 4/4) and very dark gray (N 3/0) mottles, strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) dry; weak medium angular blocky structure; very hard, firm, sticky and very plastic; few moderately thick clay films on faces of peds and in pores; common very fine roots; common very fine and fine tubular pores; strongly acid; gradual smooth boundary.

C1-40 to 53 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (10YR 5/2) dry; many fine prominent strong brown (7.5YR 5/6) and dark grayish brown (2.5Y 4/2) mottles; massive; very hard, firm, sticky and very plastic; few thin clay films in pores; few very fine roots; common very fine and fine tubular pores; strongly acid; gradual smooth boundary.

C2-53 to 64 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (2.5Y 7/2) dry; many fine prominent strong brown (7.5YR 5/6) and very dark grayish brown (2.5Y 3/2) mottles; massive; very hard, firm, sticky and very plastic; common very fine and few fine tubular pores; strongly acid.

Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 when moist and 3 or 4 when dry, and it has chroma of 1 or 2 when moist or dry. Clay content is 27 to 35 percent. The A horizon is medium acid or slightly acid. Shallow cracks may appear when the soil material is dry.

The B horizon has value of 3 or 4 when moist, and it has chroma of 1 or 2 when moist or dry. It has prominent brown, strong brown, very dark gray, or very dark grayish brown mottles. In some pedons it has

grayish brown (10YR 5/2) stains when dry. Clay content is 40 to 50 percent. The horizon is strongly acid or medium acid.

The C horizon has hue of 2.5Y or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry. It has prominent strong brown, dark grayish brown, or very dark grayish brown mottles. Clay content is 40 to 50 percent. The horizon is very strongly acid or strongly acid.

Natal Variant

The Natal Variant consists of deep, poorly drained soils on flood plains. These soils formed in recent alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 50 degrees F.

Typical pedon of a Natal Variant silty clay loam; 25 yards north of U.S. Highway 30 and about 30 yards east of pebble road; in the NW1/4 of sec. 14, T. 7 N., R. 3 W., Willamette Meridian.

A1-0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; common fine prominent brown (7.5YR 4/4) mottles; weak very fine subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine tubular pores and many fine irregular pores; strongly acid; clear smooth boundary.

C1g-8 to 16 inches; gray (5Y 5/1) clay; grayish brown (2.5Y 5/2) dry; massive; extremely hard, extremely firm, extremely sticky and extremely plastic; few fine roots; many very fine tubular pores; very strongly acid; gradual smooth boundary.

C2g-16 to 60 inches; dark greenish gray (5GY 4/1) clay, light brownish gray (2.5Y 6/2) dry; massive; extremely hard, extremely firm, extremely sticky and extremely plastic; no roots; common very fine tubular pores; very strongly acid.

The average annual soil temperature ranges from 49 to 54 degrees F. The profile is saturated with water from November through June and is dry between depths of 4 and 12 inches for less than 45 consecutive days. Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 moist when and 3 or 4 when dry, and it has chroma of 1 or 2 when moist or dry. Clay content ranges from 30 to 40 percent. The horizon is strongly acid or very strongly acid.

The C horizon has hue of 5Y, 2.5Y, or 5GY, value of 4 to 6 when moist or dry, and chroma of 1 or 2 when moist or dry. Clay content is 40 to 50 percent. The horizon is strongly acid or very strongly acid.

Quafeno Series

The Quafeno series consists of very deep, moderately well drained soils on low terraces. These soils formed in mixed silty alluvium. Slope is 0 to 8 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Quafeno loam; about 200 feet west of the junction of U.S. Highway 30 and Dike Road; in the NW1/4SW1/4NE1/4 of sec. 24, T. 3 N., R. 2 W., Willamette Meridian.

A11-0 to 6 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) 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.

A12-6 to 11 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate 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; clear smooth boundary.

B21-11 to 24 inches; dark brown (10YR 4/3) coarse silt 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; neutral; clear smooth boundary.

B22-24 to 34 inches; brown (10YR 4/3) coarse silt loam, light brown (7.5YR 6/4) dry; common distinct gray (10YR 5/1) and dark brown (7.5YR 4/4) mottles; weak coarse prismatic structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; clean sand grains coating prism faces; many very fine and fine tubular pores; slightly acid; clear smooth boundary.

B3-34 to 49 inches; dark brown (10YR 4/3) coarse silt loam, light yellowish brown (10YR 6/4) dry; common medium distinct gray (10YR 5/1) mottles and common fine faint dark brown (7.5YR 4/4) mottles; weak medium and coarse prismatic structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; slightly acid; gradual wavy boundary.

C-49 to 60 inches; dark yellowish brown (10YR 4/4) coarse silt loam, very pale brown (10YR 7/4) dry; few fine and common large prominent dark greenish gray (5GY 4/1) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; slightly acid.

Depth to bedrock is 60 inches or more. Depth to mottles in chroma of 2 or less is more than 30 inches.

The A horizon has chroma of 2 or 3. It is loam or silt loam.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist, and chroma of 3 or 4 when moist or dry. It is loam, coarse silt loam, or very fine sandy loam and averages 12 to 18 percent clay and more than 15 percent sand that is coarser than very fine sand.

The C horizon is coarse silt loam, fine sandy loam, or very fine sandy loam.

Quatama Series

The Quatama series consists of very deep, moderately well drained soils on broad terraces. These soils formed in mixed silty alluvium. Slope is 0 to 15 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Quatama silt loam; about 2 miles north of Scappoose; in the NE1/4 of sec. 36, T. 4 N., R. 2 W., Willamette Meridian.

A1-0 to 4 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; few fine iron concretions; slightly acid; clear wavy boundary.

B1-4 to 14 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; common fine iron concretions; slightly acid; clear smooth boundary.

B21-14 to 25 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; few fine dark brown (10YR 4/3) mottles; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

B22t-25 to 35 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many very fine tubular pores; few moderately thick clay films on peds; slightly acid; clear smooth boundary.

B3t-35 to 44 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4) dry; many fine distinct dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine roots; many very fine tubular pores; few thin clay films in pores; slightly acid; clear smooth boundary.

C1-44 to 60 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4) dry; many fine distinct dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) mottles; massive; slightly hard, friable, nonsticky and slightly plastic; few fine roots; many very fine tubular pores; slightly acid.

Depth to bedrock is 60 inches or more, and the thickness of the solum is 40 to 60 inches. Depth to mottles in chroma of 2 or less ranges from 15 to 30 inches. Strata of sandy loam to loamy sand are 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 when moist and chroma of 3 or 4. It is clay loam, silty clay loam, or heavy loam. It averages 27 to 35 percent clay and is more than 15 percent sand that is coarser than very fine sand. Clay films are thin to moderately thick and are in channels, in pores, and on some vertical and horizontal faces of peds.

Rafton Series

The Rafton series consists of deep, very poorly drained soils in concave areas on low flood plains. These soils formed in recent silty alluvium. Slope is 0 to 2 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Rafton silt loam; in the SE1/4NE1/4SW1/4 of sec. 33, T. 4 N., R. 1 W., Willamette Meridian.

Ap-0 to 8 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; common fine prominent yellowish red (5YR 4/6) mottles; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; medium acid; clear smooth boundary.

B21-8 to 17 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common fine prominent yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine and very fine tubular pores; slightly acid; clear smooth boundary.

B22-17 to 22 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; common medium prominent yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine and very fine tubular pores; thin brown (10YR 4/3) coatings in pores; slightly acid; clear smooth boundary.

B3-22 to 40 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common medium prominent yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine roots; many very fine tubular pores; thin brown (10YR 4/3) coatings in pores; slightly acid; clear smooth boundary.

C1g-40 to 50 inches; dark gray (5Y 4/1) silt loam, gray (10YR 6/2); many medium prominent brown (7.5YR 4/4) and strong brown (7.5YR 4/6) mottles; massive; hard, firm, sticky and plastic; no roots; many medium and few coarse tubular pores; red (5YR 3/6) coatings in pores; slightly acid; clear smooth boundary.
C2g-50 to 60 inches; dark greenish gray (5BG 4/1) silt loam; massive; hard, firm, slightly sticky and plastic; no roots; many fine and medium and few coarse tubular pores; red (5YR 3/6) coatings in pores; slightly acid.

The A horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 1 to 3 when moist or dry.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. It has distinct or prominent mottles. It is silt loam to silty clay loam and is 20 to 30 percent clay and less than 15 percent sand that is coarser than very fine sand. Thin lenses of peaty or loamy material in value of 2 or 3 and chroma of 1 are in some pedons.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist, and chroma of 0 to 2. It is stratified material ranging from silty clay loam to sandy loam. Mottles are distinct to prominent. Some areas have dark brown (7.5YR 3/2) "pipestems" as much as 0.25 inch in diameter that formed in tubular pores and channels. Thin layers of gray (10YR 6/1) ashlike material are in some pedons.

Rinearson Series

The Rinearson series consists of deep, well drained soils on ridgetops and side slopes of mountains. These soils formed in colluvium derived from siltstone and shale. Slope is 3 to 60 percent. The average annual precipitation is about 80 inches, and the average annual air temperature is about 47 degrees F.

Typical pedon of a Rinearson silt loam; 300 feet north of Deep Creek 320 Road; in the NW1/4NW1/4NW1/4 of sec. 9, T. 5 N., R. 5 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.
A11-0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; strong very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine and very fine irregular pores; strongly acid; abrupt wavy boundary.
A12-4 to 16 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; strongly acid; clear wavy boundary.
B21-16 to 24 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; very strongly acid; gradual wavy boundary.
B22-24 to 32 inches; brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; very strongly acid; gradual wavy boundary.
B3-32 to 39 inches; brown (7.5YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 15 percent soft siltstone pebbles; very strongly acid; gradual wavy boundary.
C-39 to 45 inches; yellowish brown (10YR 5/6) silt loam, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; 60 percent soft siltstone pebbles; very strongly acid; gradual wavy boundary.
CR-45 inches; partially weathered siltstone.

The solum is 30 to 45 inches thick. Depth to soft bedrock is 40 to 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma 4 to 6 when moist or dry. It is 5 to 25 percent soft siltstone pebbles and 0 to 10 percent soft siltstone cobbles. The B horizon is silt loam to silty clay loam.

The C horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is 15 to 35 percent soft siltstone pebbles and 0 to 25 percent soft siltstone cobbles.

Sauvie Series

The Sauvie series consists of very deep, poorly drained soils in broad, convex areas on flood plains. These soils formed in recent silty alluvium. Slope is 0 to 2 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Sauvie silty clay loam, protected; about 2 miles east of Scappoose and 25 feet east of Honeyman Road; in the SE1/4 of sec. 8, T. 3 N., R. 1 W., Willamette Meridian.

A11-0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; strong

medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

A12-6 to 10 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; strong medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

B21g-10 to 18 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 6/1) dry; many fine distinct dark brown (7.5YR 4/4) mottles; moderate medium prismatic structure; hard, firm, sticky and plastic; common fine roots; many fine tubular pores; medium acid; clear smooth boundary.

B22g-18 to 29 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 6/1) dry; many fine distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; many fine tubular pores; medium acid; clear smooth boundary.

IIB3g-29 to 43 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; many fine distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many fine tubular pores; medium acid; gradual wavy boundary.

IIC-43 to 60 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; many fine distinct dark brown (7.5YR 4/4) and reddish brown (5YR 4/4) mottles; massive; slightly hard, friable, sticky and plastic; common fine and medium roots; many fine tubular pores; medium acid.

The A horizon is 10 to 24 inches thick. Distinct mottles are in the lower part in some pedons. The horizon is silt loam or 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 when moist. It has distinct to prominent mottles. This horizon is 27 to 35 percent clay. In some pedons are thin lenses of peaty or loamy material that has value of 2 or 3 when moist, chroma of 1 when moist, and hue of 10YR.

The C horizon has hue of 10YR, 2.5Y, or neutral, value of 4 or 5 when moist, and chroma of 0 to 2. It is stratified sandy loam to silt loam. It has distinct or prominent mottles. In some pedons are dark brown (7.5YR 3/2) "pipestems" as much as 1 /4 inch in diameter that have formed in tubular pores and channels. Thin layers of gray (10YR 6/1) ashlike material are in some pedons.

Scaponia Series

The Scaponia series consists of deep, well drained soils on active convex side slopes of mountains. These soils formed in colluvium derived from siltstone. Slope is 30 to 90 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of a Scaponia silt loam; along Gunner's Lake Road 130; in the NW1/4SW1/4NE1/4 of sec. 22, T. 4 N., R. 3 W., Willamette Meridian.

O1-2 inches to 0; leaves, twigs, moss, and woody material.

A1-0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 10 percent soft siltstone pebbles 2 to 5 millimeters in diameter; medium acid; clear smooth boundary.

B21-7 to 19 inches; dark brown (10YR 4/3) 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; 20 percent soft siltstone pebbles and 5 percent soft siltstone cobbles; strongly acid; gradual wavy boundary.

B22-19 to 32 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 30 percent soft siltstone pebbles and 5 percent soft siltstone cobbles; strongly acid; gradual wavy boundary.

C-32 to 42 inches; dark brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and plastic; common fine roots; many very fine tubular pores; 30 percent soft siltstone pebbles and 40 percent soft siltstone cobbles; strongly acid; gradual wavy boundary.

Cr-42 to 60 inches; fractured siltstone.

Depth to bedrock is 40 to 60 inches.

The A1 horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It averages 12 to 18 percent clay and 5 to 15 percent soft siltstone pebbles.

The B21 horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 3 or 4 when moist or dry. Clay content ranges from 18 to 22 percent. The horizon is 25 to 35 percent soft siltstone pebbles and 5 to 10 percent soft siltstone cobbles.

The B22 horizon has hue of 10YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3

or 4 when moist or dry. Clay content ranges from 18 to 22 percent. The horizon is 15 to 35 percent soft siltstone pebbles and 10 to 20 percent soft siltstone cobbles.

Sifton Series

The Sifton series consists of deep, somewhat excessively drained soils on low, broad terraces. These soils formed in gravelly alluvium mixed with volcanic ash. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Sifton loam; in the SE1/4SW1/4NE1/4 of sec. 12, T. 3 N., R. 2 W., Willamette Meridian.

A11-0 to 10 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; 5 percent pebbles; strongly acid; clear smooth boundary.

A12-10 to 24 inches; black (10YR 2/1) 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 tubular pores; 5 percent pebbles; strongly acid; clear smooth boundary.

IIC1-24 to 34 inches; dark brown (10YR 3/3) extremely cobbly sand, brown (10YR 4/3) dry; massive; soft, loose, nonsticky and nonplastic; few very fine roots; many very fine and fine irregular pores; 35 percent cobbles and 40 percent pebbles; slightly acid; clear smooth boundary.

IIC2-34 to 60 inches; brown (10YR 4/3) extremely gravelly coarse sand, yellowish brown (10YR 5/4) dry; massive; weakly cemented; hard, friable, nonsticky and nonplastic; few very fine roots; many very fine and fine tubular pores; 20 percent cobbles and 55 percent pebbles; slightly acid.

The control section is 15 to 35 percent rock fragments in the upper part and 50 to 75 percent in the lower part. The profile has hue of 10YR or 7.5YR.

The A horizon has value of 2 when moist and 2 or 3 when dry, and it has chroma of 1 or 2. It is loam or gravelly loam and is 5 to 25 percent pebbles and 0 to 5 percent cobbles.

The IIC horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 2 to 4. It is very gravelly loamy coarse sand, extremely gravelly coarse sand, or very gravelly sand and is 40 to 60 percent pebbles and 10 to 25 percent cobbles.

Tolany Series

The Tolany series consists of very deep, well drained soils on broad, convex ridgetops and side slopes of mountains. These soils formed in silty colluvium. Slope is 3 to 60 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 44 degrees F.

Typical pedon of a Tolany loam; 50 feet north of road; in the NE1/4SE1/4NW1/4 of sec. 32, T. 4 N., R. 3 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.

A11-0 to 6 inches; dark reddish brown (5YR 3/3) loam, brown (7.5YR 5/4) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 15 percent concretions 1 to 3 millimeters in diameter; strongly acid; clear smooth boundary.

A12-6 to 17 inches; dark reddish brown (5YR 3/4) silt loam, brown (7.5YR 5/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 15 percent concretions 1 to 3 millimeters in diameter; medium acid; gradual wavy boundary.

B21-17 to 27 inches; reddish brown (5YR 4/4) silt loam, light reddish brown (5YR 6/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 5 percent concretions 1 to 3 millimeters in diameter; medium acid; gradual wavy boundary.

B22-27 to 40 inches; reddish brown (5YR 4/4) silt loam, light reddish brown (5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tabular pores; 5 percent concretions 1 to 3 millimeters in diameter; medium acid; gradual wavy boundary.

IIB23-40 to 60 inches; brown (7.5YR 4/4) silt loam, pink (7.5YR 7/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; few dark stains on peds; medium acid.

Depth to bedrock is 60 inches or more.

The A1 horizon has hue of 7.5YR or 5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. Clay content ranges from 10 to 15 percent. The horizon has 10 to 35 percent hard concretions.

The B2 horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 4 when moist and 6 when dry. Clay content ranges from 15 to 25 percent. The horizon has 10 to 25 percent hard concretions and 10 to 20 percent pebbles and cobbles.

Tolke Series

The Tolke series consists of deep, well drained soils on broad, stable ridgetops and side slopes of mountains. These soils formed in colluvium derived from shale and siltstone mixed with small amounts of volcanic ash. Slope is 5 to 30 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F.

Typical pedon of a Tolke silt loam; in the NW1/4SE1/4 of sec. 21, T. 7 N., R. 5 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.
A11-0 to 9 inches; dark brown (7.5YR 3/3) silt loam, brown (7.5YR 5/4) dry; strong very fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many fine and very fine roots; many very fine irregular pores; 10 percent pebbles 1 to 5 millimeters in diameter; strongly acid; clear smooth boundary.
A12-9 to 18 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; strong medium granular structure; slightly hard, friable, nonsticky and slightly plastic; many fine and very fine roots; many very fine irregular pores; 15 percent pebbles 1 to 5 millimeters in diameter; strongly acid; clear wavy boundary.
B1-18 to 26 inches; dark brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine tubular pores; few pebbles 1 to 5 millimeters in diameter; very strongly acid; clear wavy boundary.
B21-26 to 49 inches; dark brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine tubular pores; few cobbles; very strongly acid; clear wavy boundary.
B22-49 to 66 inches; brown (7.5YR 4/4) silty clay loam, yellowish brown (10YR 5/6) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many very fine tubular pores; very strongly acid; few cobbles.

Depth to bedrock is 60 inches or more.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry. It is 5 to 20 percent pebbles.

The B horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist and 5 or 6 when dry. It averages 30 to 35 percent clay and less than 15 percent sand that is coarser than very fine sand. It is as much as 15 percent rock fragments.

The C horizon is as much as 35 percent rock fragments.

Treharne Series

The Treharne series consists of deep, moderately well drained soils on low terraces of mountain streams. These soils formed in old alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 50 degrees F.

Typical pedon of a Treharne silt loam; 300 yards east of Highway 47, just south of the pebble road; in the SE1/4SE1/4NW1/4 of sec. 34, T. 5 N., R. 4 W., Willamette Meridian.

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots and common medium roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.
A12-7 to 15 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and very fine roots and few medium roots; many very fine irregular pores; very strongly acid; gradual smooth boundary.
B1-15 to 29 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, firm, slightly sticky and plastic; few thin very dark grayish brown (10YR 3/2) clay films on faces of peds; common fine and very fine roots and few medium roots; many very fine and few medium tubular pores; very strongly acid; clear wavy boundary.
B2t-29 to 41 inches; brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) dry; many medium distinct dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; hard, firm, slightly sticky and plastic; common moderately thick clay films on faces of peds and in pores; few very fine, fine, and medium roots; many fine and very fine and few medium tubular pores; very strongly acid; clear smooth boundary.
C1-41 to 55 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light grayish brown (10YR 6/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm, slightly sticky and plastic; few very fine and fine roots; many very fine and fine and few medium tubular pores; very strongly acid; clear smooth boundary.
C2-55 to 61 inches; dark gray (5Y 4/1) silty clay, gray (10YR 6/1) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; few very fine and fine roots;

few very fine and fine tubular pores; very strongly acid.

Depth to bedrock is more than 60 inches. The umbric epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. Clay content is 15 to 25 percent. The horizon is strongly acid to slightly acid.

The B horizon has value of 4 or 5 when moist and 5 to 7 when dry, and it has chroma of 2 to 6 when moist or dry. Mottles in high chroma are below a depth of 15 inches in some pedons. Mottles in chroma of 2 are between depths of 24 and 32 inches, within 10 inches of the top of the argillic horizon. The B horizon is silt loam or silty clay loam. It is 18 to 35 percent clay and is less than 15 percent sand that is coarser than very fine sand. It is very strongly acid or strongly acid.

The C horizon has hue 5Y to 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 1 to 4 when moist. Mottles are distinct or prominent and grayish brown, yellowish brown, brown, or strong brown. The horizon is silt loam, silty clay loam, or silty clay. It is very strongly acid or strongly acid.

Udifluvents

Udifluvents are very deep, well drained soils on flood plains. These soils formed in recent alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 60 inches, and the average annual air temperature is about 49 degrees F.

Reference profile of an Udifluvent; 200 feet east of Gravel Creek Mainline, along Gravel Creek; in the SE1/4NW1/4 of sec. 21, T. 4 N., R. 4 W., Willamette Meridian.

A11-0 to 8 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine pores; medium acid; abrupt smooth boundary.

AC-8 to 16 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

C1-16 to 32 inches; brown (10YR 4/3) fine sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

C2-32 to 60 inches; dark yellowish brown (10YR 4/4) loamy very fine sand, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many very fine tubular pores; medium acid.

The A horizon is silty clay loam, silt loam, or sandy loam. Rock fragment content ranges from 0 to 45 percent. Hue is 5YR, 7.5YR, 10YR, or 2.5Y.

The C horizon is silty clay, silty clay loam, silt loam, sandy loam, or loamy sand. It is stratified in some pedons. Rock fragment content ranges from 0 to 50 percent. Hue is 5YR, 7.5YR, 10YR, or 2.5Y.

Udipsamments

Udipsamments are very deep, somewhat excessively drained soils that formed in recent, sandy dredge spoil along the Columbia River. Slope is 0 to 3 percent. The average annual precipitation is about 60 inches, and the average annual temperature is about 53 degrees F.

Reference profile of an Udipsamment; 100 feet north of levee road; in sec. 33, T. 8 N., R. 5 W., Willamette Meridian.

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores, neutral.

C-4 to 60 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many irregular pores; neutral.

Because these soils formed in material dredged from the Columbia River channel, they vary widely in texture, horizonation, and base saturation. The A horizon is not present in very recent deposits. Texture ranges from coarse sand to fine sand. Flooding varies with the elevation of the deposits. Some areas are protected by levees. Base saturation is very low in some of the older deposits, but it is more than 60 percent in the more recent deposits.

Vernonia Series

The Vernonia series consists of deep, well drained soils on broad, stable ridgetops and side slopes of mountains. These soils formed in residuum and colluvium derived from shale and siltstone. Slope is 3 to 30 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 49 degrees F.

Typical pedon of a Vernonia silt loam (fig. 13); 50 feet east of road in the SE1/4SE1/4SE1/4 of sec. 14, T. 5 N., R. 4 W., Willamette Meridian.

O1-1 inch to 0; leaves, twigs, moss, and woody material.

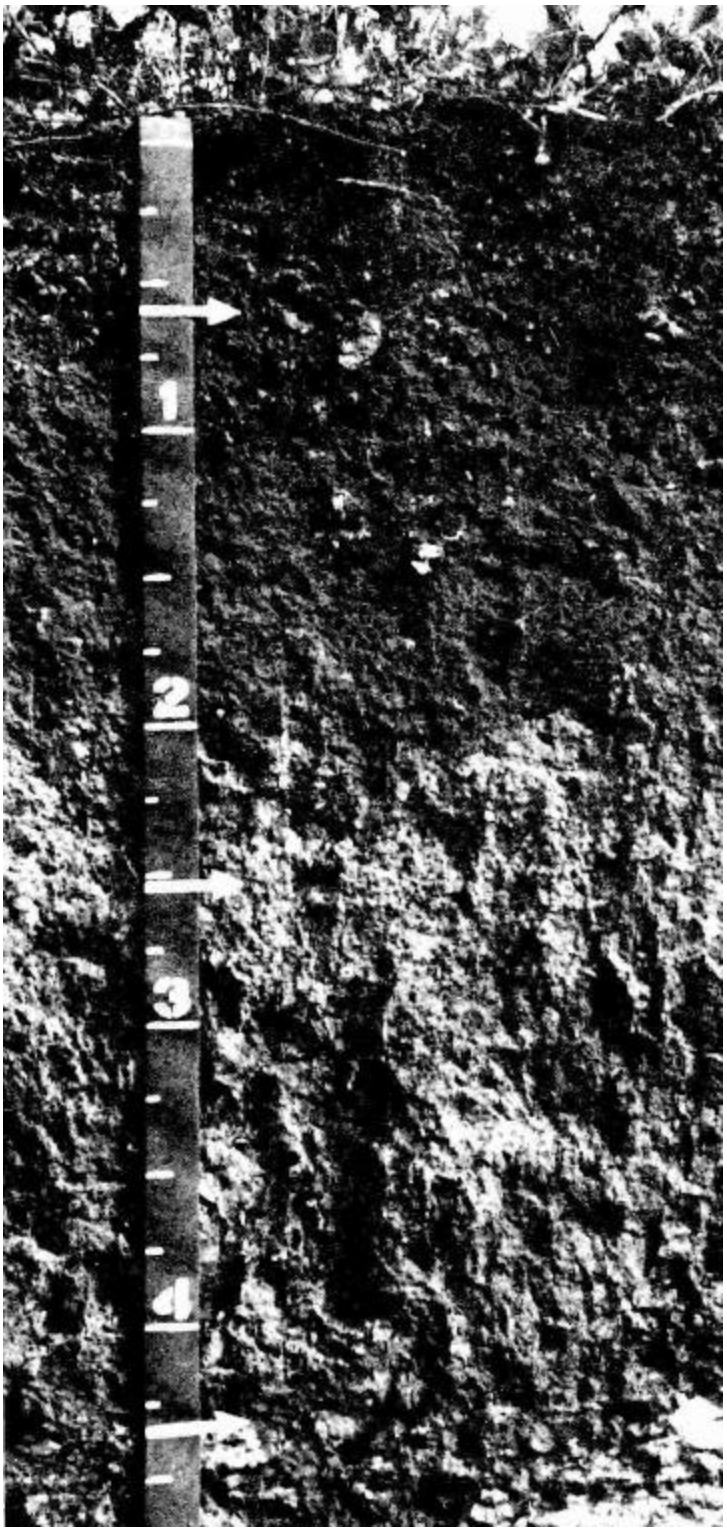


Figure 13. -Profile of Vernonia silt loam, 3 to 30 percent slopes. Weathered siltstone is at a depth of 52 inches.

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

A3-4 to 9 inches; dark brown (7.5YR 4/4) silt loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B1-9 to 21 inches; dark brown (7.5YR 4/4) silt loam, strong brown (7.5YR 5/6) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; common gray coatings on peds; strongly acid; gradual smooth boundary.

B21t-21 to 35 inches; dark brown (7.5YR 4/4) silt loam, strong brown (7.5YR 5/6) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; common moderately thick clay films on peds and in pores; very strongly acid; clear smooth boundary.

B22t-35 to 42 inches; dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; many moderately thick clay films on peds and in pores; very strongly acid; clear smooth boundary.

B3t-42 to 52 inches; dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) dry; weak coarse subangular blocky structure; hard, friable, sticky and plastic; few medium roots; many very fine tubular pores; many moderately thick clay films on peds and in pores; very strongly acid; clear smooth boundary.

many thick dark brown.(7.5YR 3/3, moist) clay films on fractures.

Depth to bedrock is 40 to 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, chroma of 4 to 6 when moist or dry, and value of 4 or 5 when moist and 4 to 6 when dry.

Wapato Series

The Wapato series consists of very deep, poorly drained soils on low flood plains. These soils formed in recent silty alluvium. Slope is 0 to 3 percent. The

average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Wapato silt loam; 100 feet south of Dutch Canyon Road; in the SW1/4NE1/4NE1/4 of sec. 16, T. 3 N., R. 2 W., Willamette Meridian.

A1-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine prominent dark reddish brown (2.5YR 3/4) mottles; moderate fine granular structure; slightly hard, friable, slightly sticky and plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

B1-10 to 19 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine distinct yellowish red (7.5YR 4/6) mottles; moderate very fine subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; many very fine irregular pores; common fine concretions; medium acid; clear smooth boundary.

B21-19 to 40 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/2) dry; many medium distinct yellowish red (7.5YR 4/6) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; medium acid; clear smooth boundary.

C-40 to 60 inches; light olive gray (5Y 6/2) silty clay loam, light gray (5Y 7/2) dry; many medium prominent yellowish red (7.5YR 4/6) mottles and few medium distinct gray (2.5Y 5/1) mottles; massive; slightly hard, firm, slightly sticky and plastic; few fine roots; common very fine tubular pores; medium acid.

The A horizon has chroma of 1 to 3 when moist. Mottles are few, fine, and faint to common, medium, and prominent.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and, chroma of 1 or 2 when moist or dry. Mottles are few, fine, and distinct to many, medium, and prominent. Texture is silty clay loam that is 30 to 35 percent clay.

The C horizon has hue of 2.5Y or 5GY, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 0 or 1 when moist or dry. The content of rock fragments below a depth of 40 inches ranges from 0 to 75 percent.

Wauld Series

The Wauld series consists of moderately deep, well drained soils on active side slopes of mountains. These soils formed in colluvium derived from basalt. Slope is 30 to 70 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 51 degrees F.

Typical pedon of a Wauld very gravelly loam, 30 to 70 percent slopes; 1 mile west of U.S. Highway 30, on Nicolai Road; in the SW1/4 of sec. 12, T. 6 N., R. 2 W., Willamette Meridian.

O1-1 inch to 0; loose litter of twigs, needles, and other woody material.

A1-0 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly loam, gray (10YR 5/1) 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; 50 percent pebbles and 10 percent cobbles; slightly acid; clear wavy boundary.

B1-10 to 16 inches; dark brown (10YR 4/3) very gravelly loam, light gray (10YR 7/2) 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; 40 percent pebbles and 10 percent cobbles; slightly acid; clear wavy boundary.

B2-16 to 33 inches; dark yellowish brown (10YR 4/4) very gravelly loam, very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 50 percent pebbles and 20 percent cobbles; slightly acid; abrupt irregular boundary.

IIR-33 inches; fractured basalt.

The umbric epipedon is 10 to 20 inches thick. The control section is loam or clay loam that is 18 to 30 percent clay and 35 to 75 percent rock fragments.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry. It is 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 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is very gravelly loam or very gravelly clay loam that is 25 to 50 percent pebbles, 10 to 25 percent cobbles, and 0 to 10 percent stones.

Wauna Series

The Wauna series consists of deep, poorly drained soils in broad, convex areas on flood plains. These soils formed in recent silty alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 65 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Wauna silt loam, protected; 100 feet north of road in the southwest corner of sec. 21, T. 8 N., R. 4 W., Willamette Meridian.

Ap-0 to 8 inches; very dark gray (10YR 3/1) silt loam, light brownish gray (10YR 6/2) dry; moderate very

fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; very strongly acid; abrupt clear boundary.

C1g-8 to 26 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; many medium strong brown (7.5YR 4/6) mottles; weak coarse prismatic structure; extremely hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores and common vertical tubular pores 3 millimeters in diameter; strongly acid; abrupt smooth boundary.

C2g-26 to 60 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; common medium prominent strong brown (7.5YR 4/6) mottles; massive; extremely hard, friable, slightly sticky and slightly plastic; common fine roots; many fine tubular pores and common vertical tubular pores 3 millimeters in diameter; strongly acid.

The A horizon is 6 to 10 inches thick. It has value of 2 or 3 when moist and 5 or 6 when dry, and it has chroma of 1 or 2 when dry or moist.

The C1 g horizon has value of 4 or 5 when moist. It has distinct to prominent mottles. This horizon is 18 to 35 percent clay. Some pedons have thin lenses of peaty material in hue of 10YR, value of 2 or 3 when moist, and chroma of 1.

The C2g horizon has hue of 10YR, 2.5Y, or neutral, value of 4 or 5 when moist, and chroma of 0 to 2. It is stratified silt loam to sandy loam. It has distinct or prominent mottles. In some areas dark brown (7.5YR 3/2) "pipestems" as much as 1 /4 inch in diameter have formed in tubular pores and channels. Thin layers of gray (10YR 6/1) ashlike material are in some pedons. Lenses of peat or muck are below a depth of 60 inches.

Wollent Series

The Wollent series consists of very deep, poorly drained soils in concave drainageways of terraces. These soils formed in silty alluvium. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Typical pedon of a Wollent silt loam; about 200 feet north of St. Helens Golf Course and 500 feet east of Hayden Road; in the SW1/4SW1/4NE1/4 of sec. 13, T. 4 N., R. 2 W., Willamette Meridian.

Ap-0 to 11 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 fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

B1-11 to 14 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common coarse distinct strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many fine and very fine tubular pores; few fine black stains; medium acid; clear smooth boundary.

B21t-14 to 24 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common coarse distinct strong brown (7.5YR 4/6) mottles; few fine black stains; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few moderately thick clay films in pores; medium acid; clear smooth boundary.

B22t-24 to 32 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; common coarse distinct dark yellowish brown (10YR 3/4) and strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; many very fine and fine tubular pores; few moderately thick clay films on peds and in pores; medium acid; clear smooth boundary.

C1-32 to 53 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; many coarse distinct dark brown (10YR 3/3) and strong brown (7.5YR 4/6) mottles; weak coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few fine roots; many very fine and fine tubular pores; medium acid; clear smooth boundary.

C2-53 to 60 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; many coarse distinct strong brown (7.5YR 4/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; medium acid.

The solum is 20 to 35 inches thick. Depth to bedrock is more than 5 feet.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry. Mottles range from none to common and are faint to distinct.

The B horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 1 or 2 when moist or dry. Mottles are distinct to prominent. The profile is silt loam or silty clay loam.

The C horizon commonly is silt loam or silty clay loam, and in some pedons it is stratified with sand to clay.

Xerochrepts

Xerochrepts are very deep, somewhat poorly drained to well drained soils on short terrace escarpments. These soils formed in alluvium. Slope is 20 to 50 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Reference profile of a Xerochrept; 200 feet north of Bennet road; in sec. 13, T. 4. N., R. 3 W., Willamette Meridian.

A1-0 to 6 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many very fine irregular pores; common fine concretions; slightly acid; clear smooth boundary.
B1-6 to 14 inches; dark brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; few distinct yellowish brown and yellowish red mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.
B2-14 to 28 inches; dark brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; many fine distinct dark brown and yellowish red mottles and common very fine prominent grayish brown mottles; moderate medium subangular blocky structure; hard, very firm, slightly sticky and slightly plastic; brittle; many very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
B3-28 to 38 inches; dark brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; weak coarse subangular blocky structure; hard, very firm, slightly sticky and slightly plastic; brittle; common very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
C1-38 to 60 inches; dark yellowish brown (10YR 4/4) fine sandy loam, yellowish brown (10YR 5/4) dry; many very fine prominent grayish brown (10YR 5/2), yellowish red (5YR 4/6), and brown (10YR 5/3) mottles; massive; hard, very firm, nonsticky and nonplastic; brittle; few fine roots; many very fine tubular pores; medium acid.

Depth to bedrock is more than 60 inches. These soils formed in sandy, silty, or clayey material. They are on metastable to active terrace fronts. The profile is 0 to 50 percent coarse fragments. It has hue of 5YR, 7.5YR, 10YR, or 2.5Y. Diagnostic soil horizons range from cambric to entic. Reaction is neutral to medium acid.

Xeropsamments

Xeropsamments are somewhat excessively drained soils that formed in recent, coarse textured dredge spoil along the Columbia River. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, and the average annual temperature is about 53 degrees F.

Reference profile of a Xeropsamment; on south end of Deer Island; 50 feet north of Deer Island Slough; in sec. 16, T. 5 N., R. 1 W., Willamette Meridian.

A1-0 to 3 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.
C1-3 to 12 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose; few very fine and fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.
C2-12 to 18 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine tubular pores; neutral; abrupt smooth boundary.
C3-18 to 30 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; few fine distinct dark brown (7.5YR 4/4) mottles; single grain; loose; few fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.
C4-30 to 60 inches; very dark grayish brown (2.5Y 3/2) loamy fine sand, grayish brown (2.5Y 5/2) dry; few fine distinct dark brown (7.5YR 4/4) mottles; single grain; loose; few fine roots; many very fine irregular pores; neutral.

Because these soils formed in material dredged from the Columbia River channel, they vary widely in horizonation, texture, and base saturation. The A horizon is not present in areas of very recent deposits. Texture ranges from coarse sand to loamy coarse sand. Flooding varies with the elevation of the deposits. Base saturation is very low in some of the older deposits, but it is more than 60 percent in the more recent deposits that are not subject to weathering.

Xerumbrepts

Xerumbrepts are well drained soils that are shallow to igneous rock. They formed in old alluvium. Slope is 0 to 15 percent. The average annual precipitation is about 45 inches, and the average annual air temperature is about 53 degrees F.

Reference profile of a Xerumbrept; 300 feet north of Old St. Helens Road and 100 feet east of electrical substation; in the SE1/4NW1/4 of sec. 9, T. 4. N., R. 1 W., Willamette Meridian.

A11-0 to 10 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; strong very fine granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots; many very fine irregular pores; 10 percent basalt pebbles; medium acid; clear smooth boundary.
A12-10 to 18 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable, nonsticky

and nonplastic; many very fine roots; many very fine irregular pores; 10 percent basalt pebbles; medium acid; abrupt wavy boundary. R-18 inches; igneous rock.

Depth to bedrock ranges from 1 inch to 30 inches. Rock fragment content ranges from 0 to 40 percent. Hue is 5YR, 7.5YR, 10YR, or 2.5Y. Reaction is slightly acid or medium acid.

Formation of the Soils

Dr. R. B. Parsons, research soil scientist, Soil Conservation Service, assisted in preparing this section.

Soil is a natural, three-dimensional body on the Earth's surface; it supports plants. Its characteristics and properties have been determined by physical and chemical processes that result from the interaction of climate, living organisms, time, topography, and parent material (24). The influence of any one of these factors varies from place to place, but the interaction of all the factors determines the kind of soil that forms.

Soils in Columbia County have been greatly influenced by such factors as the cold, wet, short growing season at the higher elevations in the Coast Range and the warm, long growing season at the lower elevations along the Columbia River. The age and type of parent material have greatly influenced soil development in areas of recent alluvium along the Columbia River flood plains and in areas of old alluvium on terraces. In the higher lying areas, colluvium and residuum derived from sedimentary and igneous rock mixed with volcanic ash have imparted distinct characteristics to the soils.

In this section the soil-forming factors of climate and living organisms are discussed separately. Time, topography, and parent material are grouped and discussed under "Geomorphic Surfaces and Soil Development."

Climate

Climate has a strong influence on soil formation. Temperature and moisture greatly influence the kinds of vegetation that grow and the rate at which organic matter decomposes and minerals weather. They also influence the rate of removal of material from some soil horizons and the rate of accumulation in others.

In this county there are three major climatic zones that greatly influence soil genesis: (1) areas with warm, dry summers and cool, moist winters, (2) areas with warm, moist summers and cool, moist winters, and (3) areas with warm, moist summers and cold, moist winters. In areas on bottom lands and low uplands in the southeastern part of the county, the summers are warm and dry and the winters are cool and moist. The soils in these areas formed under a xeric moisture regime (22). The growing season is long; plant growth begins early in spring and continues through midsummer. On young geomorphic surfaces, the accumulation of organic matter and the limited leaching of bases have produced Mollisols such as the Cloquato, McBee, Quafeno, and Sauvie soils. On older surfaces the soil forming factors have been active for longer periods of time, and Haploxeralfs such as Latourell and Quatama soils have formed. In areas where organic matter accumulation has been slower or where man has removed portions of the epipedon, Ochrepts such as Aloha and Multnomah soils have formed. In areas at elevations of less than 1,500 feet in the northern and western parts of the county, summers are warm and moist and winters and are cool and moist. The soils in these parts of the county formed under an udic moisture regime (21). Most of this climatic zone is represented by older surfaces on which Utisols such as Bacona and Mayger soils have formed. Plant growth begins late in spring and continues until late in summer or early in fall. On the younger surfaces, slower accumulation of organic matter and actively eroding slopes have resulted in the formation of Inceptisols such as Braun, Dowde, and Scaponia soils.

In areas at elevations of more than 1,500 feet, summers are warm and moist and winters are cold and moist. The growing season is short, and plant growth and the kinds of plants that are included in the climax plant community are limited. These areas are in the Coast Range physiographic province (8). The soils are developing under a western hemlock plant community. There generally is enough plant growth on these soils for the development of an umbric epipedon. Leaching is moderate, so base saturation is not excessively low; therefore, frigid Umbrepts such as Caterl and Murnen soils have formed.

Living Organisms

Living organisms, especially the higher plants, are an active factor 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 and by the parent material, topography, and age of the soil.

Plants provide a cover that reduces erosion and helps to 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, which permits water to penetrate. The uprooting of trees by wind also mixes soil layers and loosens the underlying material.

In Columbia County the soils have formed under various plant communities. In the xeric zone, grass and a mixed coniferous and deciduous forest of Oregon white oak, bigleaf maple, and Douglas-fir are prominent in the plant community. The annual dieback of roots provides large amounts of organic material and facilitates nutrient

cycling. The grass absorbs calcium and other bases and returns them into the soil annually, thus reducing the effects of leaching. Under these conditions Mollisols such as the Cloquato and Quafeno soils developed. In the udic zone, the proportion of conifers increases. Organic matter has accumulated; however, bases are absorbed by the conifers and are primarily returned to the soil surface rather than being returned to the entire soil profile. The higher precipitation in these areas has resulted in more leaching of bases; therefore, soils that have a more nearly base-depleted umbric epipedon, such as the Goble, Hembre, and Klickitat soils, have formed.

Small animals, earthworms, insects, and microorganisms influence the formation of soils in several ways. They mix organic matter into the mineral soil material and accelerate the decomposition of plant remains into organic matter. 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 rock and the decomposition of organic matter.

In this county conditions generally are favorable for most organisms. Earthworms are very common in all areas except the frigid zone. Small animals such as gophers and moles are common in the lower lying, warmer areas. Man has played a prominent role in soil development by dredging sand from the Columbia River and depositing it on the adjacent flood plain. Many areas of Xeropsamments and Udipsamments consist of sandy dredged material.

Geomorphic surfaces and Soil Development

Geomorphic surfaces were mapped on high-altitude aerial photographs or topographic quadrangles for the Coast Range, including the eastern part of Columbia County. The surfaces were visually traced throughout the survey area. Sequential relationships among surfaces, stereoscopic observations, elevation, and photo interpretation of tonal patterns were used to map the surfaces. Each geomorphic surface is named for a locality where the particular surface is well expressed (14).

The geomorphic surfaces fit a time sequence, but there are exceptions that are noted in the discussion of individual surfaces. A complete sequence of the surfaces in the order of their age from the youngest to the oldest is as follows: Horseshoe, Ingram, Winkle, Champoeg, Senecal, Dolph, and Eola. Small areas of the Horseshoe and Ingram surfaces make up the Luckiamute unit.

Steep, broken topography that has some slopes of more than 100 percent characterizes the Looney geomorphic unit. Because of the variable stability of the landscape, the soils and surfaces of the Looney unit fit no particular span of time; therefore, it is not considered a geomorphic surface.

Horseshoe surface.-The Horseshoe surface is the lower of the two flood plains in the county. It has low relief and includes the stream channel and associated areas such as point bar deposits, channel fillings, and abandoned meanders. The surface generally is underlain by coarse textured or moderately coarse textured alluvium. Many areas of the Horseshoe surface are not vegetated or support young stands of willows or cottonwoods. Areas of this surface in the survey area are dominantly at elevations of 0 to 800 feet. Annual flooding inundates the Horseshoe surface. Rapid changes in the surface result from cutting of new channels, abandonment of older channels, lateral migration of meanders, and downstream movement of alluvial deposits. The Horseshoe surface began to form only a short time ago, as shown by the presence of metallic artifacts in the alluvium. It is estimated that it is of post-settlement age, since the middle of the 19th century.

The Horseshoe surface is typified by soils of the Lacoda, Moag, and Rafton series (Typic Fluvaquents) and by Riverwash. The soils are so young that they have no diagnostic horizons other than an ochric epipedon and they exhibit an irregular decrease in organic matter as depth increases. The source of the organic matter is the alluvial parent material.

Ingram surface.-The Ingram surface is the higher of the two flood plains in the county. The topography of the Ingram surface typically is undulating, and relief of as much as 10 feet is produced by overbank channeling during periods of flooding. The bars and channels have an approximate orientation parallel to the streams. In some valleys the bars are seldom, if ever, flooded. The characteristics of the microrelief of this surface are 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. Areas of this surface in the survey area generally are at elevations of 10 to 800 feet. The soils are mainly silty clay loam, but some sandy strata are common.

Radiocarbon tests date the sediment associated with the Ingram surface from 550 to 3,290 years ago; therefore, the change in the stream system that caused abandonment of the Winkle surface as a flood plain occurred 3,290 to 5,250 years ago (6). 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 Cumulic Ultic Haploxerolls such as Cloquato and McBee soils and Fluvaquentic Haplaquolls such as Sauvie and Wapato soils. The Cloquato and McBee soils have a mollic epipedon, primarily because

of the alluvial parent material that has an irregular decrease in organic matter content as depth increases. These soils have a moderate to strong structure and have been in place long enough to exhibit a cambic B horizon. The Sauvie and Wapato soils have a mollic epipedon, have moderate prismatic or blocky structure in the cambic horizon, and show evidence of gleying and the mobility of ferrous iron to form distinct mottles.

Luckiamute unit.-This unit is on flood plains of small drainageways that contain local alluvium derived from the erosion of material associated with the Bethel, Dolph, and Eola surfaces and the Looney unit. As defined, the concept of the Luckiamute unit includes areas of the Horseshoe and Ingram surfaces and, in places, areas of the Winkle surface that are too small to separate at the scale used.

The topography of the Luckiamute unit is typical of that of flood plains of small streams. Relief is absent except for minor corrugations as a result of channeling. A few small alluvial fans that extend out of small valleys are included in the Luckiamute unit. These fans contain sediment of variable composition, depending upon what was eroded in the immediate source area. As the Luckiamute unit can be directly traced to the Horseshoe and Ingram surfaces, it is assumed that the age of the unit brackets the age of the surfaces in the larger valleys.

The soils of the Luckiamute unit are dominantly those of the Sauvie, Locoda, Rafton, McBee, and Wapato soils, which are included in the description of the Horseshoe and Ingram surfaces. Delena soils are in swales and drainageways, and they have formed in slope alluvium (9) derived from upland silt (16) and from clayey, relict Paleosols upslope.

Winkle surface.-The middle to early Holocene Winkle surface is the oldest surface related to the present drainage systems in the Pacific Northwest. Most of the Winkle surface has the morphology typical of abandoned flood plains of aggrading streams. In this county, particularly along the Columbia River, the bars and channels exhibit considerably greater relief than, for instance, those along the Nehalem River and its major tributaries. The elevation differences between the bars and channels are largely a result of the competence of the stream, so the Columbia River is expected to have the best expression of this geomorphic feature. 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. Elevations of the Winkle surface in this county generally are 35 to 800 feet. Surface texture of the sediment is dominantly silt and clay, which commonly are underlain by stratified sand and pebbles at a depth of 2 to 6 feet.

A few areas of the Winkle surface are low terraces that have slight microrelief and are rarely flooded. Included are small areas of Humaquepts, ponded, in abandoned channels. The dates of the sediment beneath the Winkle surface as determined by carbon-14 methods range from 5,250 to 12,240 years ago. Many areas of the Winkle surface along the Columbia River contain strata of volcanic ash from the eruption of Mt. Mazama about 6,600 years ago.

The well drained Sifton soils and the moderately well drained Quafeno soils are typical of soils that formed in sediment associated with the Winkle surface. The Quafeno soils are in the convex areas of the Winkle surface. The surface has been stable for a sufficient period of time for the Quafeno soils (Aquultic Haploxerolls) to have developed a mollic epipedon and an organic matter profile that is the result of pedogenesis rather than on inherent property of the alluvial parent material. Quafeno soils have been leached of bases since the early Holocene; they have a base saturation of 50 to 75 percent. These soils have a cambic horizon.

The Sifton soils have a dark-colored umbric epipedon and a gravelly cambic horizon overlying very gravelly or very cobbly sand. The solum is strongly smeary because of the content of volcanic ash, both airfall and alluvial. The ash is probably from the eruption of Mt. Mazama.

Champoeg surface.-The geomorphic episode that resulted in the development of the Champoeg surface at the close of the Pleistocene severely modified remnants of the older surfaces. Areas of the Champoeg surface in this county are along the Columbia River. It is a relatively minor surface consisting of rock-floored (strath) terraces and dunelike landforms graded to a base level that remained stable, but only for a short period of time.

Deposits associated with the Champoeg surface in this county consist of cross-bedded pebbles and cobbles. It is probable that the source of the sediment was the Missoula, or Spokane, Floods (1,4), as the times proposed for these catastrophic floods fit the geomorphic sequence and correspond to carbon-14 dates locally obtained. Trimble (19) attributed the pebble to a catastrophic flood formed by the emptying of Lake Missoula in Montana into the Columbia River. Elevations of the Champoeg surface in Columbia County generally are 100 to 170 feet.

The outwash during the Champoeg geomorphic episode truncated older surfaces in its path, as is evidenced by rock outcroppings and thin sediment deposited over bedrock at St. Helens. The pebble faces of the Portland Sand and Gravel are present in the Columbia City and Deer Island areas.

In this county, Multnomah soils (Dystric Xerochrepts) formed in material underlying the Champoeg surface. Development of an ochric epipedon, a cambic horizon, and weak structure is the dominant evidence of soil development. The presence of a lithologic discontinuity at a depth of 38 inches and a thin solum over a substratum of very gravelly sand have facilitated the leaching of these soils. Base saturation is 24 to 39

percent in the solum. Clay eluviated in the Multnomah soils could easily be translocated through the underlying pebbles. Some evidence of clay eluviation in the pebbles is evidenced by clay coatings on the bottom of the pebbles.

Senecal surface.-The Senecal geomorphic episode is preserved as terrace remnants along major streams that are deeply incised below the former late Pleistocene valley floor in the county. Elevation ranges from 150 to 350 feet. The rock-floored Senecal surface, a strath terrace, consists of Rock outcrop and Xerumbrepts.

Typical soils of the Senecal surface are those of the Aloha, Latourell, and Quatama Series. The Latourell and Quatama soils have an ochric epipedon and exhibit a prominent argillic horizon. These soils formed under forest vegetation,. Although their texture is similar to that of the Multnomah soils, the profile is thick enough to retain eluviated clay and form a distinct elluvial horizon. Leaching over a period of time has been adequate to maintain a base saturation of 35 to 75 percent. These soils are Ultic or Aquultic Haploxeralfs.

The Aloha soils are in areas that have a low slope gradient. They have a slightly brittle, dense, weakly cemented B horizon, are somewhat poorly drained, and are classified as Aquic Xerochrepts. The Aloha soils have a few thin clay films on peds and in pores. The moderately slow permeability of these soils, which is caused by the presence of a weak fragipan and low relief, tends to inhibit the eluviation of clay to form an argillic horizon. The slightly brittle horizon strongly resembles material of the Wyatt Member of the Willamette Formation (7). Wollent soils (Humaquepts) are in drainageways and are associated with Aloha soils.

Dolph surface.-Topography of the Dolph surface varies, but it lies well above the general level of valley floors. The surface occurs as remnants of extensive flats that have been dissected to form a rolling topography composed of a complex group of landforms that could be further divided into terraces, pediments, and upland remnants. The shoulders of valleys that grade to the Luckiamute unit are included in the Dolph surface. The pediment back slopes, foot slopes, and alluvial toe slopes in small tributary valleys are included in the concept of the Luckiamute unit and its local alluvium. The Dolph surface may be underlain by bedrock, weathered pebble, saprolite, or clay deposits. On the basis of its position on the landscape and the degree of weathering of the underlying material, the Dolph surface is considered to be of middle Pleistocene age (8). In places the Dolph surface is mantled by the Upland Silt described by Schlicker (16). Elevation commonly is 400 to 600 feet.

Soils representative of the Dolph surface in Columbia County are those of the Cornelius and Delena series. The Cornelius soils exhibit some depletion of bases, have an argillic horizon above the fragipan, and have clay films in the fragipan. The thickness of the, solum over the fragipan in Cornelius soils allows clay to be illuviated into material above the pan. The cornelius soils have had a long enough period of time to form that the profile exhibits strong horizonation.

Eola surface.-The Eola surface consists of erosional remnants of the oldest stable geomorphic surface in the area. The undulating to nearly level areas around Alston, Apiary, and Fern Hill are representative of the Eola surface. Relief of the Eola surface is moderate; remnants typically are rounded hills and valleys and have as much as 150 feet of local relief. Hanging valleys are common. Slope ranges from 2 to 20 percent, and elevation ranges from 450 to 1,500 feet, but most areas generally are 600 to 800 feet.

The Eola surface is considered to be nearly of Pleistocene age. It undoubtedly was quite extensive; however, erosion during the late Pleistocene and the Holocene removed much of this surface so that only small remnants remain. Areas of the Looney unit generally join the Eola surface and join it to younger; lower lying surfaces. In the northern and the eastern uplands of the county, the Eola surface is overlain by enigmatic silt (23) that in some places contains erratic pebbles and cobbles (6). The silty mantle is 13 to 100 inches thick (18) on stable Eola summits, but it is not present in areas a few miles to the west. This material is called Upland Silt. It is about 19 percent sand, 64 percent silt, and 17 percent clay (19). It overlies bedrock, saprolite, or a reddish Paleosol, perhaps the Diamond Hill Paleosol, which may be the precursor of Bacona soils.

The Eola surface in this county is typified by the Bacona, Goble, and Cascade soils. The Bacona soils are Ultisols; they exhibit the most advanced stage of weathering and leaching of bases in the survey area. Studies of soils of the Eola surface show that deep, red soils with a prominent argillic horizon are primarily on stable ridgetops and pediment remnants (13, 14).

The Cascade soils (Typic Fragiumbrepts) developed in the Tualatin Mountains, in the southeastern part of the county. They commonly are overlain by a buried Paleosol. Soil-stratigraphic relationships indicate that the Bacona soils and similar Ultisols are relict Paleosols, probably equivalent to the Diamond Hill Paleosol or the Helvetia Formation, which may be the same Paleosol. Some Cascade soils contain several discontinuities based on mineralogic and stratigraphic evidence and, in some places, have two fragipans that are superimposed with an angular unconformity. The development of some Cascade soils is restricted by a relatively impermeable fragipan and by erosion over a period of time because of the steepness of slope or proximity to steep areas.

Goble soils (Andic Fragiumbrepts) and Cascade soils are at similar elevations on the Eola geomorphic surface, and both have formed in Upland Silt. Goble soils, however, have volcanic ash mixed in the profile and are 30 to 45 inches deep to a fragipan. Other soils

associated with the Eola geomorphic surface are those of the Kenusky and Mayger Series.

Looney unit.-The Looney unit has no particular age connotation; therefore, is not considered to be a geomorphic surface. The terrain of the Looney unit is completely dissected and is predominantly steeply sloping. Slope exceeds 100 percent in some areas. Steep, broken topography mapped as the Looney unit may join any other two surfaces, or they may make up large areas of mountainous terrain so thoroughly dissected that no geomorphic surfaces are recognizable. Erosion is active on much of the Looney unit, and there are some areas of mass soil movement (fig. 14). There are occasional remnants of some of the oldest geomorphic surfaces in the area.

The variability in age makes the Looney unit useful for geomorphic mapping of mountainous areas. The unit has three significant slope breaks, which correspond to stable, metastable, and active slopes. The valley floors and small alluvial cones are areas of the Luckiamute unit included in the Looney unit. Soils of the Looney unit have developed in colluvium derived from igneous and sedimentary rock mixed with volcanic ash.

Soils in Columbia County that are representative of the Looney unit are those of the Alstony, Braun, Dowde, and Scaponia series. The Alstony soils (Entic Dystrandepts) formed in material high in content of volcanic ash, have an ochric epipedon and a cambic horizon, are 40 to 60 inches deep over basalt, and have steep, metastable or active slopes. The Braun soils (Dystric Eutochrepts) have

Figure 14.-Mass soil movement has resulted in irregular relief in areas of the Looney unit.

an ochric epipedon and a cambic horizon and are 20 to 40 inches deep to sedimentary rock. The Dowde soils (Typic Dystrochrepts) have an ochric epipedon, a cambic horizon, and are more than 60 inches deep to bedrock. The Scaponia soils (Umbric Dystrochrepts) have an ochric epipedon and a cambic horizon and are 40 to 60 inches deep to sedimentary rock. The Braun, Dowde, and Scaponia soils are on active slopes, and they formed in alluvium and colluvium.

Other soils in the mesic zone of the Looney unit are mainly Haplumbrepts such as Hembre, Klickitat, Rinearson, and Wauld soils and steep Xerochrepts. Soils in the frigid zone at the higher elevations include those of the Caterl, Murnen, Tolke, and Tolany series (Haplumbrepts and Dystrandepts).

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Glossary

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

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

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.

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

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

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

Breast height. An average height of 4 1 /2 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

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

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter, in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site is properly managed.

Coarse fragments. Mineral or rock particles larger than 2 millimeters in diameter.

Coarse textured soil. Sand or loamy sand.

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

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Very cobbly soil material is 35 to 60 percent of these rock fragments, and extremely cobbly soil material is more than 60 percent.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

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.-Readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-Adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

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

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

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

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

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

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

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.-These soils have very high and high hydraulic conductivity and low water holding capacity. They are not suited to crop production unless irrigated.

Somewhat excessively drained.-These soils have high hydraulic conductivity and low water holding capacity. Without irrigation, only a narrow range of crops can be grown and yields are low.

Well drained.-These soils have intermediate water holding capacity. They retain optimum amounts of moisture, but they are not wet close enough to the surface or long enough during the growing season to adversely affect yields.

Moderately well drained.-These soils are wet close enough to the surface or long enough that planting or harvesting operations or yields of some field crops are adversely affected unless artificial drainage is provided. Moderately well drained soils commonly have a layer with low hydraulic conductivity, a wet layer relatively high in the profile, additions of water by seepage, or some combination of these.

Somewhat poorly drained.-These soils are wet close enough to the surface or long enough that planting or harvesting operations or crop growth is

markedly restricted unless artificial drainage is provided. Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, a wet layer high in the profile, additions of water through seepage, or a combination of these.

Poorly drained.-These soils commonly are so wet at or near the surface during a considerable part of the year that field crops cannot be grown under natural conditions. Poorly drained conditions are caused by a saturated zone, a layer with low hydraulic conductivity, seepage, or a combination of these.

Very poorly drained.-These soils are wet to the surface most of the time. They are wet enough to prevent the growth of important crops (except rice) unless artificially drained.

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

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

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

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

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

Extrusive rock. Igneous rock derived from deep-seated molten matter (magma) emplaced on the Earth's surface.

Fast intake (in tales). 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 according 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.

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

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

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

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

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

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

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.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

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

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

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

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

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced

by soil-forming processes. In the identification of soil horizons, an 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. 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.

E horizon.-The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the number 2 precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-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.

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

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.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

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

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are *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. *Sprinkler.*-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

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.

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.

Low strength. The soil is not strong enough to support loads.

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

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

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

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

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

Moderately coarse textured soil. Coarse sandy loam, sandy loam, 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).

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

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

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

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

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.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

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

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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.

Potential native plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site is properly managed. (See climax plant community.)

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

Prescribed burning. The application of fire to land under such conditions of weather, soil moisture, and time of day as presumably will result in the intensity of heat and spread required to accomplish specific forest management, wildlife, grazing, or fire hazard reduction purposes.

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.

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

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

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

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

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

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

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

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts 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 groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Saprolite (soil science). Unconsolidated residual material 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.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site class. A grouping of site indexes into 5 to 7 production capability levels. Each level can be represented by a site curve.

Site curve (50-year). A set of related curves on a graph that shows the average height of dominant trees for the range of ages on soils that differ in productivity. each level is represented by a curve. The basis of the curves is the height of dominant trees that are 50 years old or are 50 years old at breast height.

Site curve (100-year). A set of related curves on a graph that show the average height of dominant and codominant trees for a range of ages on soils that differ in productivity. Each level is represented by a curve. The basis of the curves is the height of

dominant and codominant trees that are 100 years old or are 100 years old at breast height.

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.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

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.

Soft rock. Rock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil compaction. An alteration of soil structure which ultimately can affect the biological and chemical properties. Soil compaction decreases voids and increases bulk density.

Soil puddling. This condition occurs in certain soils when they are wet. Exerting mechanical force destroys the soil structure by compression and shearing. It results in the rearrangement of the soil particles to a massive or nonstructural state and generally accompanies the compaction process.,

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), *blocky* (angular or subangular), and *granular.* Structureless soils are either *single grained* (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilting a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the E horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Talus. Rock fragments of any size or shape, commonly coarse and angular, derived from and tying at the base of a cliff or very steep, rock slope. The accumulated mass of such loose, broken rock formed chiefly by falling, rolling, or sliding.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Third order valleys. A valley produced by a third order stream. In a drainageway network, the smallest unbranched tributaries are designated order one, the confluence of two first order streams produces a second order stream, a confluence of two second order streams produces a third order stream, and so on.

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.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The action of uprooting and tipping over trees by the wind.