Foreword

This soil survey contains information that can be used in land-planning programs in Thurston County. 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 ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

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.

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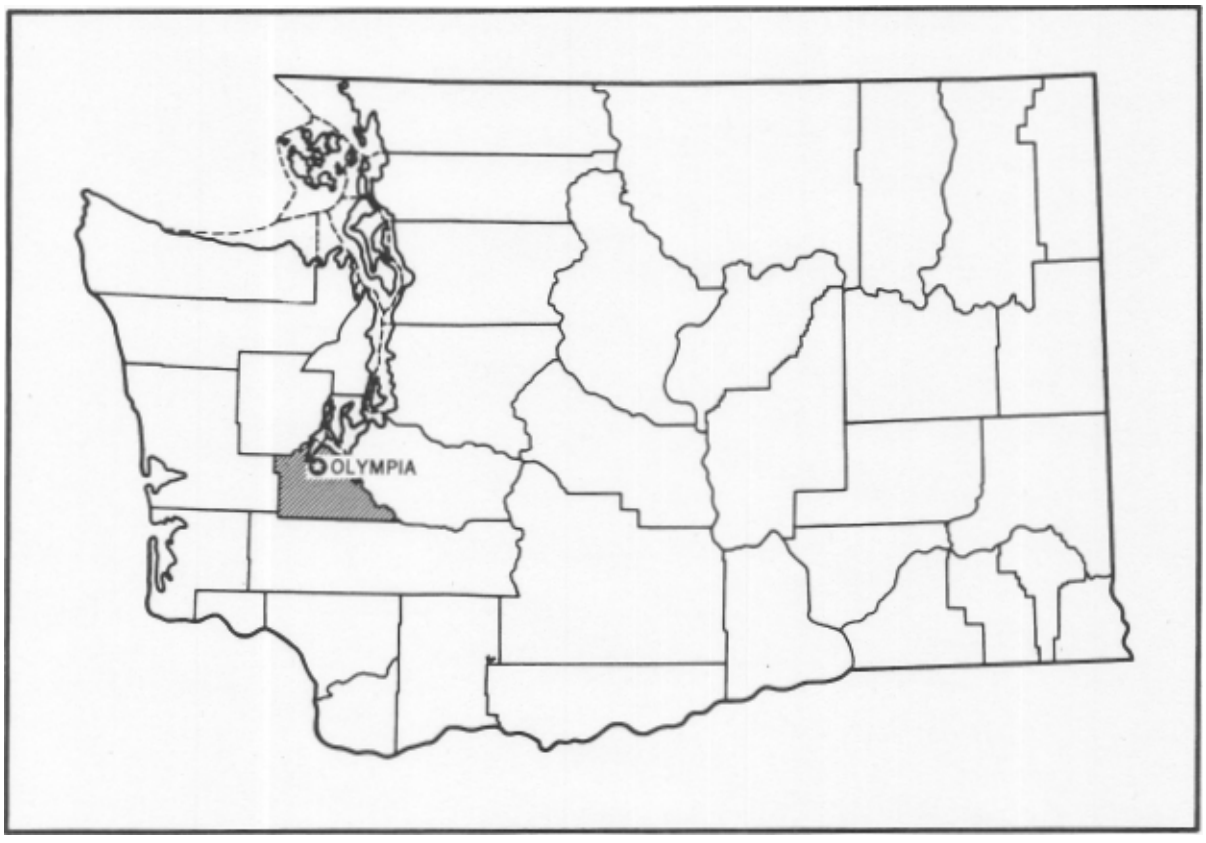

Location of Thurston County in Washington.

Soil Survey of
Thurston County, Washington

By Russell F. Pringle, Soil Conservation Service

Soils surveyed by Russell F. Pringle and Carl J. McMurphy, Soil Conservation Service, and Ken Schlichte, Nick Comerford, Gerry Richardson, Norman Mofield, Chien-Lu Ping, and Harry Anderson, Washington State Department of Natural Resources

United States Department of Agriculture, Soil Conservation Service, in cooperation with
Washington State Department of Natural Resources and Washington State University, Agriculture Research Center

THURSTON COUNTY has a total acreage of 487,040 acres, or 761 square miles. It is in the western part of Washington, at the southern end of Puget Sound. The county is bounded on the east by the Nisqually River, which separates it from Pierce County. Many narrow inlets of Puget Sound form most of the irregular northern boundary, and the small regular part of this boundary joins Mason County. Grays Harbor County forms the western boundary, and Lewis County is to the south. Olympia, which is in the north-central part of the county, is the county seat and state capital. It is about 30 miles southwest of Tacoma and 60 miles southwest of Seattle.

This soil survey updates soil surveys published in 1958, 1964, 1966, and 1968 and an unpublished soil survey completed in 1973 (*6*, *11, 12, 15, 16).* It provides larger maps and more detailed interpretive information about the soils.

General Nature of the County

This section provides general information about Thurston County. It describes physiography and drainage, history and development, and climate.

Physiography and Drainage

Thurston County is on a glacial plain that extends northward from a mountainous rim. It is bordered on the west, south, and east by mountains. Along the western boundary are low-lying mountain chains. The Black Hills and their adjoining ridges and spurs are in this area. The elevation at Capitol Peak is 2,658 feet. The mountains are mainly rounded peaks and ridges of basalt.

Along the western part of the southern border are low, rolling foothills and mountain spurs. The Michigan Hills, which are about 700 feet high, are in this area.

Farther east, across the Chehalis River Valley and on the Lewis County border, are other mountain spurs. These spurs include Baldhill, Porcupine Ridge, and the Northcraft Mountains. The highest point in the county, 2,984 feet, is on a ridge running into the county from the Stahl and Ladd Mountains.

Thurston County is drained by five different river systems. These systems are the Black, Chehalis, Deschutes, Nisqually, and Skookumchuck Rivers.

History and Development

Because the main north-south migration route for settlers ended at Puget Sound, the area that later became Thurston County was the site of the first permanent American settlement on the Sound. It was also the site of the territorial capital. Thurston County was organized in 1853. It originally included the entire

area along Puget Sound from the Cowlitz River to the Canadian border. The present boundaries of Thurston County were established in 1861.

Agriculture was originally, and still is, a significant part of the economy. Timber production became a major economic factor in the 1850's and has remained so to this day. Sandstone quarrying and coal mining were in full swing around Tenino and Bucoda in the 1870's. This part of the county's past may well be reborn as coal deposits become increasingly marketable.

The closing of quarries and sawmills and the decline of coal mining and agriculture has caused growth to be slow in rural areas. At times in the county's history, settlers abandoned the area, engaging in a search for gold or other more lucrative efforts. The country's governmental sector reflected the slow growth pattern. Although the state capital was in the county, many state offices were located in the more populated urban areas.

During the period 1960-74, Thurston County became the second fastest growing county in the state. This sudden change resulted from an unusually high rate of immigration to the county. Immigration of newcomers has stemmed from the spillover growth of Tacoma and Fort Lewis and from legislated centralization of state offices in Olympia.

In 1974, Thurston County had a population of 83,900. It was the seventh most populated county of the state's 39 counties. It has the seventh smallest land base and the eighth highest population density per square mile in Washington State.

The present pattern of land use is that of an urban core partially surrounded by single-family suburbs, which, in turn, give way to rural areas where timber and agriculture are the main land uses. More than half of the region's population live in the urban core of Olympia, Lacey, and Tumwater. These cities cover approximately 20 square miles and have a population density of 2,000 people per square mile. The remaining 741 square miles of the county accommodates approximately 39,000 people (14,000 residences) and has a population density of 56 people per square mile. In these rural areas, development has taken place primarily along the roads and shorelines, leaving the interior largely undeveloped (18).

Because only 5 percent of the county's total land area has been developed for urban uses, the stately forests and clean air and water have been maintained. There are over 100 miles of saltwater coastline and more than 100 freshwater lakes in the county. Halfway between Seattle and Portland on a major interstate transportation route, Thurston County is at the gateway to the Olympic Peninsula.

Climate

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

The climate of Thurston County is greatly tempered by winds from the Pacific Ocean. Summers are fairly warm, and hot days are rare. Winters are cool, and snow and freezing temperatures are common only at the higher elevations. Irrigation is needed because rainfall is extremely light in summer, when several weeks often pass without precipitation. During the rest of the year, rains are frequent, especially in late fall and winter.

In most winters one or two storms throughout the survey area bring strong and sometimes damaging winds, and in some years the accompanying heavy rains cause serious flooding. Every few years, in either winter or summer, the invasion of a large continental airmass from the east results in temperatures that are well below freezing for several consecutive days in winter or in a week or more of sweltering heat in summer.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Olympia, La Grande, and Centralia, Washington. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 39 degrees F at Olympia and 41 degrees at La Grande and Centralia. and the average daily minimum temperature is 33 degrees at Olympia, 34 degrees at La Grande, and 35 degrees at Centralia. The lowest temperature on record, which occurred at Olympia on January 27, 1972, is -7 degrees. In summer, the average temperature is 62 degrees at Olympia and 63 degrees at Centralia and La Grande, and the average daily maximum temperature is about 75 degrees at all three locations. The highest recorded temperature, which occurred at La Grande and Centralia on August 17, 1977, 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 about 51 inches at Olympia, 39 inches at La Grande, and 47 inches at Centralia. Of these totals, about 21 percent at Olympia, 32 percent at La Grande, and 24 percent at Centralia usually fall in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.33 inches at Olympia on November 19, 1962. Thunderstorms occur on about 5 days each year.

The average seasonal snowfall is about 15 inches at Olympia, 17 inches at La Grande, and 9 inches at Centralia. The greatest snow depth at any one time during the period of record was 24 inches at La Grande. On an average of less than 5 days, at least 1 inch of snow is on the ground. The number of such days varies from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 90 percent. The sun shines 65 percent of the time in summer and 30 percent in winter. The prevailing wind is from the south-southwest. Average windspeed is highest, 8 miles per hour, in winter.

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 into 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 soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. 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 well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils 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

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association 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 association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils 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 association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

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

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

Soil Descriptions

Soils on Flood Plains

These soils make up about 5 percent of the county. The native vegetation is mainly conifers, hardwoods, and grasses. Elevation is 100 to 500 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 210 days.

These soils are nearly level, very deep, and well drained. They formed in alluvium derived from mixed sources. They are used as hayland, pasture, cropland, woodland, or homesites.

1. Chehalis-Newberg Association

Very deep, well drained, nearly level soils; on flood plains

These soils are along the major rivers in the county. Slope is 0 to 3 percent. The native vegetation is mainly grasses and sedges and an overstory of conifers and hardwoods. Elevation is 100 to 500 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 210 days.

This association makes up about 5 percent of the county. It is about 31 percent Chehalis soils, 16 percent Newberg soils, and 53 percent soils of minor extent.

Chehalis soils formed in alluvium. Typically, the surface layer is silt loam. The subsoil is silty clay loam. The substratum to a depth of 60 inches or more is loam.

Newberg soils formed in alluvium. Typically, the surface layer is loam and fine sandy loam. The substratum to a depth of 60 inches or more is fine sandy loam.

Of minor extent in this association are the poorly drained Godfrey and Puget soils, the moderately well drained Maytown and Sultan soils, the somewhat excessively drained Pilchuck soils, the well drained Puyallup soils, and the very poorly drained Tacoma soils.

This association is used as hayland, pasture, cropland, woodland, or homesites. It is well suited to hayland, pasture, and cropland. Flooding is a hazard on sites for homes.

Soils on Glacial Uplands

These soils make up about 60 percent of the county.

The native vegetation is mainly conifers. Elevation is 50 to 900 feet. The average annual precipitation is 35 to 60 inches, the average annual air temperature is 49 to 51 degrees F. and the average frost-free period is 150 to 200 days.

These soils are nearly level to steep, moderately deep to very deep, and moderately well drained to somewhat excessively drained. They formed in glacial outwash and till derived dominantly from mixed sources.

Most areas of these soils are used as homesites, woodland, hayland, pasture, or cropland. A few areas are sources of gravel.

2. Spanaway-Nisqually Association

Very deep, somewhat excessively drained. nearly level to rolling soils; on glacial outwash terraces

These soils are mainly in the central part of the county. Slope is 0 to 15 percent. The native vegetation is mainly grasses and scattered conifers. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 18 percent of the county. It is about 45 percent Spanaway soils, 15 percent Nisqually soils, and 40 percent soils of minor extent.

Spanaway soils formed in glacial outwash. Typically, the surface layer is gravelly sandy loam. The subsoil is very gravelly sandy loam. The substratum to a depth of 60 inches or more is extremely gravelly sand.

Nisqually soils formed in sandy glacial outwash. Typically, the surface layer and subsoil are loamy fine sand. The substratum to a depth of 60 inches or more is loamy sand.

Of minor extent in this association are the moderately well drained Cagey and Yelm soils, the well drained Eld soils, the poorly drained Everson and McKenna soils, and the somewhat poorly drained Spana soils.

This association is used as hayland, pasture, cropland, or homesites or as a source of gravel. Some small areas are used as woodland. In the areas of hayland, pasture, or cropland, the main limitation is a low available water capacity during the growing season. The main problem on sites for septic tank absorption fields is around water contamination caused by a poor filtering capacity.

3. Alderwood-Everett Association

Moderately deep and very deep, moderately well drained and somewhat excessively drained, nearly level to steep soils; on glacial till plains

These soils are mainly in the northern and northeastern parts of the county. Slope is 0 to 50 percent. The vegetation is mainly conifers and hardwoods. Elevation is 50 to 700 feet. The average annual precipitation is 35 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 35 percent of the county. It is about 22 percent Alderwood soils, 21 percent Everett soils, and 57 percent soils of minor extent.

Alderwood soils are on broad glacial till plains. These soils are moderately deep and moderately well drained. They formed in ablation till over basal till. Typically, the surface layer and the upper part of the subsoil are gravelly sandy loam. The lower part of the subsoil is very gravelly sandy loam. Below this is weakly cemented glacial till.

Everett soils are on terrace moraines and terrace escarpments. These soils are very deep and somewhat excessively drained. They formed in glacial outwash. Typically, the surface layer is very gravelly sandy loam. The subsoil and the upper part of the substratum are extremely gravelly loamy sand and extremely gravelly sandy loam. The lower part of the substratum to a depth of 60 inches or more is extremely gravelly sand.

Of minor extent in this association are the well drained Baldhill and Giles soils, the poorly drained Bellingham, Everson, and Norma soils, the moderately well drained Hoogdal and Kapowsin soils, the somewhat excessively drained Indianola soils, the very poorly drained Mukilteo soils, and the somewhat poorly drained Skipopa soils.

This association is used as hayland, pasture, woodland, or homesites. In the areas of hayland and pasture, the main limitation is low precipitation during the growing season. The main limitation on homesites is the seasonal wetness of the Alderwood soils.

4. Cathcart-Tenino Association

Deep and moderately deep, well drained, nearly level to steep soils; on glacial uplands and terminal moraines

These soils are mainly in the south-central part of the county. Slope is 3 to 65 percent. The vegetation is mainly conifers and hardwoods. Elevation is 50 to 900 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 5 percent of the county. It is about 52 percent Cathcart soils, 46 percent Tenino soils, and 2 percent soils of minor extent.

Cathcart soils are on uplands. These deep soils formed in glacial drift and volcanic ash over sandstone and siltstone. Typically, the surface layer is gravelly loam. The subsoil is silt loam, and the substratum is clay loam. Weathered siltstone or sandstone bedrock is at a depth of about 44 inches.

Tenino soils are on terminal moraines. These moderately deep soils formed in glacial till over glacial outwash. Typically, the surface layer is gravelly loam. The subsoil is gravelly loam and gravelly sandy loam. The upper part of the substratum is weakly cemented very gravelly loam. The lower part to a depth of 60 inches or more is extremely gravelly sandy loam.

Of minor extent in this association are the moderately well drained Alderwood soils, the somewhat excessively drained Everett and Indianola soils, and the poorly drained McKenna and Norma soils.

Most of this association is used as woodland. A few small areas are used as hayland, pasture, or homesites. In areas of hayland or pasture, the main limitation is a low available water capacity during the growing season. Slope is a limitation on sites for homes.

Soils on Uplands and Mountains

These soils make up about 26 percent of the county. The native vegetation is mainly conifers. Elevation is 200 to 2,800 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 43 to 51 degrees F, and the average frost-free period is 120 to 200 days.

These soils are nearly level to very steep. moderately deep to very deep, and moderately well drained and well drained. They formed in residuum and colluvium weathered from basalt and andesite and from some siltstone and sandstone. Most areas of these soils are used as woodland.

5. Baumgard-Wilkeson Association

Deep and very deep, well drained. sloping to steep soils: on uplands and mountains

These soils are in the southeastern part of the county. Slope is 5 to 65 percent. The native vegetation is conifers. Elevation is 400 to 1,600 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 47 or 48 degrees F, and the average frost-free period is 125 to 175 days.

This association makes up about 13 percent of the county. It is about 46 percent Baumgard soils, 25 percent Wilkeson soils, and 29 percent soils of minor extent.

Baumgard soils are on uplands. These deep soils formed in residuum and colluvium derived dominantly from andesite. Typically, the surface layer is loam. The subsoil is clay loam and very gravelly clay loam. Fractured andesite is at a depth of about 45 inches.

Wilkeson soils are on uplands and mountains. These very deep soils formed in material weathered from andesite and basalt. Typically, the surface layer is silt loam. The subsoil to a depth of 60 inches or more is gravelly silty clay loam and gravelly clay loam.

Of minor extent in this association are the well drained Jonas and Pheeney soils, the moderately well drained Mashel and Rainier soils, and the somewhat poorly drained Scamman soils.

This association is used for woodland, recreational development, or wildlife habitat.

6. Pheeney-Mal Association

Moderately deep and very deep, well drained and moderately well drained, sloping to very steep soils; on mountain slopes

These soils are in the southeastern part of the county. Slope is 5 to 90 percent. The native vegetation is mainly conifers. Elevation is 1,500 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 120 to 170 days.

This association makes up about 4 percent of the county. It is about 55 percent Pheeney soils, 9 percent Mal soils, and 36 percent soils of minor extent.

Pheeney soils are on mountainsides. These soils are moderately deep and well drained. They formed in residuum and colluvium derived from andesite mixed with volcanic ash. Typically, the upper part of the surface layer is gravelly loam, and the lower part is gravelly silt loam. The subsoil is very gravelly silt loam. Slightly weathered, fractured andesite is at a depth of about 30 inches.

Mal soils are on foothills and mountainsides. These soils are very deep and moderately well drained. They formed in material derived from highly weathered, tuffaceous marine siltstone and sandstone mixed with volcanic ash in the upper part. Typically, the surface layer and the upper part of the subsoil are clay loam. The lower part of the subsoil to a depth of 60 inches or more is clay.

Of minor extent in this association are the well drained Jonas and Vailton soils and the somewhat poorly drained Scamman soils.

This association is used for woodland, recreational development, or wildlife habitat.

7. Olympic-Raught Association

Very deep, well drained, sloping to steep soils; on uplands

These soils are in the western part of the county. Slope is 5 to 65 percent. The native vegetation is mainly conifers. Elevation is 200 to 1,600 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 50 or 51 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 7 percent of the county. It is about 32 percent Olympic soils, 21 percent Raught soils, and 47 percent soils of minor extent.

Olympic soils formed in material weathered from basalt. Typically, the surface layer is silt loam. The upper part of the subsoil is silty clay loam, and the lower part to a depth of 60 inches or more is clay.

Raught soils formed in material weathered from basalt. Typically, the surface layer is silt loam. The subsoil to a depth of 60 inches or more also is silt loam.

Of minor extent in this association are the very deep Boistfort soils, the deep Bunker soils, and the moderately deep Katula and Lates soils.

This association is used for woodland, recreational development, or wildlife habitat.

8. Schneider-Delphi Association

Deep, well drained, nearly level to steep soils; on foothills, mountains, and uplands

These soils are in the northwestern part of the county. Slope is 3 to 65 percent. The native vegetation is conifers and hardwoods. Elevation is 100 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is 49 or 50 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 4 percent of the county. It is about 49 percent Schneider soils, 35 percent Delphi soils, and 16 percent soils of minor extent.

Schneider soils are on foothills and mountains. They formed in colluvium derived from basalt. Typically, the surface layer is very gravelly loam and very gravelly silt loam. The subsoil is extremely gravelly silt loam. Fractured basalt is at a depth of about 55 inches.

Delphi soils are on glacial uplands. They formed in continental glacial till. Typically, the surface layer is very gravelly loam. The subsoil is extremely gravelly silt loam. Weakly cemented glacial till is at a depth of about 48 inches.

Of minor extent in this association are the somewhat excessively drained Grove soils and the well drained Giles soils.

This association is used for woodland, recreational development, or wildlife habitat. Some small areas are used as homesites. Slope is a limitation on the homesites.

Soils on Sedimentary Uplands and Glacial Drift Plains

These soils make up about 9 percent of the county. The native vegetation is conifers and hardwoods. Elevation is 200 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

These soils are nearly level to steep, deep and very deep, and moderately well drained and well drained. They formed in highly weathered marine siltstone and sandstone and in highly weathered, ancient glacial drift. Most areas of these soils are used as woodland, hayland, pasture, or homesites.

9. Salkum-Prather Association

Deep and very deep, well drained and moderately well drained, nearly level to steep soils; on upland terraces

These soils are mainly in the southwestern part of the county. Slope is 3 to 30 percent. The native vegetation is conifers. Elevation is 200 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 2 percent of the county. It is about 66 percent Salkum soils, 14 percent Prather soils, and 20 percent soils of minor extent.

Salkum soils are deep and well drained. They formed in highly weathered, ancient glacial drift. Typically, the surface layer is silty clay loam. The subsoil to a depth of 60 inches or more is silty clay.

Prather soils are very deep and moderately well drained. They formed in highly weathered, ancient glacial drift. Typically, the surface layer is silty clay loam. The upper part of the subsoil is silty clay, and the lower part to a depth of 60 inches or more is clay.

Of minor extent in this association are the somewhat poorly drained Galvin and Scamman soils.

This association is used as woodland, hayland, pasture, or homesites. Shrinking and swelling and seasonal wetness are problems on sites for homes.

10. Melbourne-Centralia Association

Deep and very deep, well drained, gently sloping to steep soils; on uplands

These soils are in the southern part of the county. Slope is 5 to 65 percent. The native vegetation is conifers and hardwoods. Elevation is 200 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

This association makes up about 7 percent of the county. It is about 58 percent Melbourne soils, 30 percent Centralia soils, and 12 percent soils of minor extent.

Melbourne soils are deep. They formed in residuum and colluvium derived from highly weathered marine siltstone. Typically, the surface layer and the upper part of the subsoil are silty clay loam. The lower part of the subsoil to a depth of 60 inches or more is clay loam.

Centralia soils are very deep. They formed in residuum derived from highly weathered, micaceous marine sandstone. Typically, the surface layer is silt loam. The subsoil to a depth of 60 inches or more is clay loam.

Of minor extent in this association are the somewhat poorly drained Galvin and Scamman soils.

This association is used for woodland, recreational development, or wildlife habitat. Some small areas are used as homesites.

Broad Land Use Considerations

The general soil map is an aid in planning the general use and management of areas of land. It should not be used when sites for specific uses are selected or when management programs for individual farms are designed. Specific, detailed data about soils can be found in the section "Detailed Soil Map Units" and in the tables at the back of this survey.

Approximately 70 percent of the soils in Thurston County is used for the production of commercial timber. Productivity for Douglas-fir is high in associations 5, 6, 7. 8, 9, and 10. Because of the slope, carefully constructing logging roads helps to control erosion and stream sedimentation. Operating heavy, tracked and wheeled equipment only during the dry summer months minimizes compaction and puddling.

About 20 percent of the county is used for hay, pasture, hay silage, sweet corn, corn silage, peas, small grain, or blueberries. Cropland is in scattered areas throughout the county, but it is concentrated mainly in associations 1, 2, and 3. The soils in association 1 are subject to flooding during the winter. Because the flooding occurs after row crops have been harvested, crop damage is minimal. In poorly drained areas and depressional areas, however, damage to perennial grasses and fall-planted small grain can be severe. Blueberries are grown on Mukilteo soils, which are of minor extent in association 3.

About 25,000 acres in the county has been classified as urban or built-up land. In general, the nearly level to sloping Alderwood, Everett, Indianola, and Spanaway soils have a high potential for urban development. These soils are mainly in association 3. The principal soil limitations affecting urban uses in the other associations are low strength, wetness, and slope. Soils on flood plains, such as those in association 1, are severely limited as sites for homes.

The potential for recreational development ranges from low to high, depending on the type of recreation, the intensity of the expected use, and the properties of the soils. Most of the soils in associations 2 and 3 have a high potential for intensive recreational development. The soils in association 1 have a low potential because of flooding. The slope in associations 4, 5, 6, 7, 8, 9, and 10 is a limitation on sites for such recreational areas as playgrounds and camping areas. Small areas that are suitable for intensive recreational development may be included in associations that otherwise have a low potential for this kind of development. The soils in all of the associations are suitable for extensive recreational uses, such as hiking or horseback riding.

The potential for wildlife habitat is generally high throughout the county. The soils in associations 1, 2, and 3 have a high potential for openland wildlife habitat. Those in associations 4, 5, 6, 7, 8, 9, and 10 have a high potential for woodland wildlife habitat. Some of the soils on the flood plains and in the upland depressions in associations 1 and 3 have a high potential for wetland wildlife habitat.

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, 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, Alderwood gravelly sandy loam, 3 to 15 percent slopes, is a phase in the Alderwood 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. Baumgard-Pheeney complex, 10 to 40 percent slopes, is an example.

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

The descriptions, names, and delineations of the soils in this soil survey do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, or variations in the intensity of mapping or the extent of soils in the survey areas.

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 and capabilities for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Soil Descriptions

1-Alderwood gravelly sandy loam, 0 to 3 percent slopes. This moderately deep, moderately well drained soil is on glacial till plains. It formed in ablation till overlying basal till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown gravelly sandy loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 15 inches is dark brown very gravelly sandy loam. A weakly cemented hardpan is at a depth of about 30 inches. It is strongly compacted and crushes to very gravelly loamy sand. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Bellingham, McKenna, and Norma soils in drainageways and Everett and Indianola soils on terraces. Also included are small areas of Alderwood gravelly sandy loam that have slopes of 3 to 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid above the hardpan in the Alderwood soil and very slow in the pan. Available water capacity is low. Effective rooting depth is 20 to 40 inches. A perched seasonal high water table is at a depth of 18 to 36 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland or homesites. It is also used for hay and pasture.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 111. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are salal, evergreen huckleberry, cascade Oregongrape, western brackenfern, and western swordfern.

The main limitations affecting hay and pasture are the low available water capacity, the seasonal high water table, and the soil depth, which is limited by the hardpan. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation. and restricted grazing during wet periods help to keep the pasture in good condition. Irrigation is needed for maximum yields. Irrigation water can be applied by sprinklers.

If this unit is used for homesites, the main limitation is the seasonal wetness. The soil can support large loads. A drainage system should be installed on sites for buildings with basements or crawl spaces. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. The hazard of erosion is increased if the surface is bare during site development. Pebbles and cobbles should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch,

fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants.

The main limitations on sites for septic tank absorption fields are the depth to the hardpan and the seasonal wetness. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall.

This map unit is in capability subclass IVw.

2-Alderwood gravelly sandy loam, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on glacial till plains. It formed in ablation till overlying basal till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown gravelly sandy loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 15 inches is dark brown very gravelly sandy loam, A weakly cemented hardpan is at a depth of about 30 inches. It is strongly compacted and crushes to very gravelly loamy sand. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Everett. Indianola, Kapowsin, and Skipopa soils on terraces. Also included are small areas of Alderwood gravelly sandy loam that have slopes of 0 to 3 percent or 15 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid above the hardpan in the Alderwood soil and very slow in the pan. Available water capacity is low. Effective rooting depth is 20 to 40 inches. A perched seasonal high water table is at a depth of 18 to 36 inches from November to March. Water flows along the top of the hardpan and can seep at the bottom of slopes. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used for woodland or homesites. A few areas are used for hay and pasture.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 111. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are salal, evergreen huckleberry, cascade Oregongrape, western brackenfern, and western swordfern.

The main limitation affecting homesites is the seasonal wetness. This soil can support large loads. A drainage system should be installed on sites for buildings with basements or crawl spaces. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. Excavation for roads and buildings increases the hazard of erosion. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. The hazard of erosion is increased if the surface is bare during site development. Pebbles and cobbles should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants.

The main limitations on sites for septic tank absorption fields are the hardpan and the seasonal wetness. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. During the rainy season, effluent from onsite sewage disposal systems may seep at points downslope. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

The main limitations affecting hay and pasture are the low available water capacity, the seasonal high water table, and the soil depth, which is limited by the hardpan. Grasses and legumes grow well if fertilizer is applied. The seedbed should be prepared on the contour or across the slope where practical. Grazing when the soil is wet damages the plants and 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 control erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and helps to control weeds. In some years irrigation is needed for maximum yields. Irrigation water can be applied by the sprinkler method.

This map unit is in capability subclass IVe.

3-Alderwood gravelly sandy loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacial till plains. It formed in ablation till overlying basal till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown gravelly sandy loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 15 inches is dark brown very gravelly sandy loam. A weakly cemented hardpan is at a depth of about 30 inches. It crushes to very gravelly loamy sand. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Everett, Hoogdal. Indianola, and Kapowsin soils on terraces. Also included are small areas of Alderwood gravelly sandy loam that have slopes of 3 to 15 percent or 30 to 50 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid above the hardpan in the Alderwood soil and very slow in the pan. Available water capacity is low. Effective rooting depth is 20 to 40 inches. A perched seasonal high water table is at a depth of 18 to 36 inches from November to March. Water flows along the top of the hardpan and can seep at the bottom of slopes. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used for woodland. A few areas are used for pasture.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 111. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Skid trails and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are salal, evergreen huckleberry, cascade Oregongrape, western brackenfern, and western swordfern.

The main limitations affecting pasture are the low available water capacity, the seasonal high water table, the slope, and the soil depth, which is limited by the hardpan. The seedbed should be prepared on the contour or across the slope where practical. Grazing when the soil is wet damages the plants and 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 protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Irrigation is needed for maximum yields. Irrigation water can be applied by the sprinkler method.

This map unit is in capability subclass IVe.

4-Alderwood gravelly sandy loam, 30 to 50 percent slopes. This moderately deep, moderately well drained soil is on terrace escarpments. It formed in ablation till overlying basal till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 200 days.

Typically, the surface layer is *very* dark brown gravelly sandy loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly sandy loam, and the lower 15 inches is dark brown very gravelly sandy loam. A weakly cemented and strongly compacted hardpan is at a depth of about 30 inches. It crushes to very gravelly loamy sand. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Everett, Hoogdal, and Kapowsin soils. Also included are small areas of Alderwood gravelly sandy loam that have slopes of 15 to 30 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderately rapid above the hardpan in the Alderwood soil and very slow in the pan. Available water capacity is low. Effective rooting depth is 20 to 40 inches. A perched seasonal high water table is at a depth of 18 to 36 inches from November to March. Water flows along the top of the hardpan and can seep at the bottom of slopes. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 111. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Droughtiness in the surface layer reduces the seedling survival rate. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are salal, evergreen huckleberry, cascade Oregongrape, western brackenfern, and western swordfern.

This map unit is in capability subclass Vle.

5-Baldhill very stony sandy loam, 0 to 3 percent slopes. This deep, well drained soil is on terminal moraines. It formed in stony ablation till. The native vegetation is mainly conifers and hardwoods. Elevation is 400 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark brown very stony sandy loam about 4 inches thick. The upper 25 inches of the subsoil is dark yellowish brown and dark brown very stony sandy loam, and the lower 25 inches is olive brown and dark yellowish brown very gravelly sandy loam and extremely gravelly sandy loam. 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 Alderwood, Everett, and Kapowsin soils on terraces and Mukilteo and Norma soils in depressions. Also included are small areas of Baldhill very stony sandy loam that have slopes of 3 to 15 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Baldhill soil and very rapid in the substratum. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. A few areas are used for homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, western hemlock, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the surface stoniness. The stones hinder harvesting and can cause breakage of timber when the trees are felled. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings.

Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are trailing blackberry, cascade Oregongrape, western swordfern, salal, and bunchberry dogwood.

The main limitation affecting homesites is the stoniness on and below the surface. Plans for homesites should provide for the preservation of as many trees as possible. Pebbles, cobbles, and stones should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Cutbanks are not stable and are subject to sloughing. The main limitation affecting septic tank absorption fields is the stoniness.

This map unit is in capability subclass VIs.

6-Baldhill very stony sandy loam, 3 to 15 percent slopes. This deep, well drained soil is on terminal moraines. It formed in stony ablation till. The native vegetation is mainly conifers and hardwoods. Elevation is 400 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark brown very stony sandy loam about 4 inches thick. The upper 25 inches of the subsoil is dark yellowish brown and dark brown very stony sandy loam, and the lower 25 inches is olive brown and dark yellowish brown very gravelly sandy loam and extremely gravelly sandy loam. 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 Alderwood, Everett, and Kapowsin soils on terraces. Also included are small areas of Baldhill very stony sandy loam that have slopes of 0 to 3 percent or 15 to 30 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Baldhill soil and very rapid in the substratum. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. A few areas are used for homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, western hemlock, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the surface stoniness. The stones hinder harvesting and can cause breakage of timber when the trees are felled. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are trailing blackberry, cascade Oregongrape, western swordfern, salal, and bunchberry dogwood.

The main limitation affecting homesites is the stoniness on and below the surface. Excavation for roads and buildings increases the hazard of erosion. The hazard of erosion also is increased if the surface is bare during site development. Plans for homesites should provide for the preservation of as many trees as possible. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. Pebbles, cobbles, and stones should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Cutbanks are not stable and are subject to sloughing.

The main limitation affecting septic tank absorption fields is the stoniness. Slope hinders installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass VIs.

7-Baldhill very stony sandy loam, 15 to 30 percent slopes. This deep, well drained soil is on terminal moraines. It formed in stony ablation till. The native vegetation is mainly conifers and hardwoods.

Elevation is 400 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark brown very stony sandy loam about 4 inches thick. The upper 25 inches of the subsoil is dark yellowish brown and dark brown very stony sandy loam. The lower 25 inches is olive brown and dark yellowish brown very gravelly sandy loam and extremely gravelly sandy loam. 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 Alderwood, Everett, and Kapowsin soils on terraces. Also included are small areas of Baldhill very stony sandy loam that have slopes of 3 to 15 percent or 30 to 60 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Baldhill soil and very rapid in the substratum. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder. bigleaf maple, western hemlock, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the surface stoniness. The stones hinder yarding and can cause breakage of the timber when the trees are felled. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available in areas of this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are trailing blackberry, cascade Oregongrape, western swordfern, salal, and bunchberry dogwood.

This map unit is in capability subclass VIs.

8-Baldhill very stony sandy loam, 30 to 60 percent slopes. This deep, well drained soil is on terminal moraines. It formed in stony ablation till. The native vegetation is mainly conifers and hardwoods. Elevation is 400 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark brown very stony sandy loam about 4 inches thick. The upper 25 inches of the subsoil is dark yellowish brown and dark brown very stony sandy loam, and the lower 25 inches is olive brown and dark yellowish brown very gravelly sandy loam and extremely gravelly sandy loam. 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 Alderwood, Everett,, and Kapowsin soils on terraces. Also included are small areas of Baldhill very stony sandy loam that have slopes of 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Baldhill soil and very rapid in the substratum. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches. Runoff is rapid. and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, western hemlock, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 153 cubic feet per acre per year at 60 years of age.

The main limitations affecting the harvesting of timber are slope and stones on the surface. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. The stones hinder harvesting and can cause breakage of timber when the trees are felled. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction

is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are trailing blackberry, cascade Oregongrape, western swordfern, salal, and bunchberry dogwood.

This map unit is in capability subclass VIs.

9-Baumgard loam, 10 to 40 percent slopes. This deep, well drained soil is on uplands. It formed in residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers. Elevation is 400 to 1,600 feet. The average annual precipitation is 55 to 65 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is 150 to 175 days.

Typically, the surface layer is dark reddish brown loam about 14 inches thick. The upper 16 inches of the subsoil is reddish brown and yellowish red clay loam. The lower 15 inches is dark yellowish brown very gravelly clay loam. Fractured andesite is at a depth of about 45 inches. Depth to the andesite ranges from 40 to more than 60 inches.

Included in this unit are small areas of Mashel. Pheeney. Scamman. and Wilkeson soils. Also included are small areas of Baumgard loam that have slopes of 40 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Baumgard soil. Available water capacity is high. Effective rooting depth is 40 to more than 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve.. it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, red huckleberry, western brackenfern, western swordfern, and salal.

This map unit is in capability subclass IVe.

10-Baumgard loam, 40 to 65 percent slopes. This deep, well drained soil is on upland hillsides and ridgetops. It formed in residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers. Elevation is 400 to 1,600 feet. The average annual precipitation is 55 to 65 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is 150 to 175 days.

Typically, the surface layer is dark reddish brown loam about 14 inches thick. The upper 16 inches of the subsoil is reddish brown and yellowish red clay loam. The lower 15 inches is dark yellowish brown very gravelly clay loam. Fractured andesite is at a depth of about 45 inches. Depth to the andesite ranges from 40 to more than 60 inches.

Included in this unit are small areas of Mashel and Pheeney soils. Also included are small areas of Baumgard loam that have slopes of 10 to 40 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Baumgard soil. Available water capacity is high. Effective rooting depth is 40 to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for woodland. Douglas-fir is the

main woodland species. Among the trees of limited extent are red alder. western hemlock, western redcedar. and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, red huckleberry, western brackenfern, western swordfern, and salal.

This map unit is in capability subclass VIIe.

11-Baumgard-Pheeney complex, 10 to 40 percent slopes. This map unit is on uplands. The native vegetation is mainly conifers. Elevation is 1,000 to 1,800 feet. The average annual precipitation is 55 to 65 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is 150 to 175 days.

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

The Baumgard soil is deep and well drained. It formed in residuum and colluvium derived dominantly from andesite. Typically, the surface layer is dark reddish brown loam about 14 inches thick. The upper 16 inches of the subsoil is reddish brown and yellowish red clay loam. The lower 15 inches is dark yellowish brown very gravelly clay loam. Fractured andesite is at a depth of about 45 inches. Depth to the andesite ranges from 40 to more than 60 inches.

Permeability is moderate in the Baumgard soil. Available water capacity is high. Effective rooting depth is 40 to more than 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Pheeney soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite. Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick. The lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

Included in this unit are small areas of Jonas, Mashel, Rainier, Scamman, and Wilkeson soils. Also included are small areas of Baumgard and Pheeney soils that have slopes of 40 to 65 percent. Included areas make up about 20 percent of the total acreage.

This unit is used for woodland. Douglas-fir is the main woodland species on the Baumgard soil. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

Douglas-fir and western hemlock are the main woodland species on the Pheeney soil. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber on this unit is the muddiness caused by seasonal wetness and occasional snow pack. Use of wheeled and

tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber on this unit. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. Droughtiness in the surface layer of the Pheeney soil reduces the seedling survival rate. When openings are made in the canopy on this unit, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings on the Baumgard soil and can delay the establishment of planted Douglas-fir seedlings and the natural reforestation of western hemlock on the Phenney soil. Because the rooting depth is restricted by the underlying bedrock, trees on the Pheeney soil are subject to occasional windthrow.

Among the common forest understory plants are cascade Oregongrape, western swordfern, vine maple, red huckleberry, and salal.

This map unit is in capability subclass VIe.

12-Baumgard-Pheeney complex, 40 to 65 percent slopes. This map unit is on uplands. The native vegetation is mainly conifers. Elevation is 1,000 to 1,800 feet. The average annual precipitation is 55 to 65 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is 150 to 175 days.

This unit is about 45 percent Baumgard loam and 30 percent Pheeney gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

The Baumgard soil is deep and well drained. It formed in residuum and colluvium derived dominantly from andesite. Typically, the surface layer is dark reddish brown loam about 14 inches thick. The upper 16 inches of the subsoil is reddish brown and yellowish red clay loam. The lower 15 inches is dark yellowish brown very gravelly clay loam. Fractured andesite is at a depth of about 45 inches. Depth to the andesite ranges from 40 to more than 60 inches.

Permeability is moderate in the Baumgard soil. Available water capacity is high. Effective rooting depth is 40 to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

The Pheeney soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite. Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick. The lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Permeability and available water capacity are moderate in the Pheeney soil. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Included in this unit are small areas of Jonas, Mashel, and Rainier soils. Also included are small areas of Baumgard and Pheeney soils that have slopes of 10 to 40 percent. Included areas make up about 25 percent of the total acreage.

This unit is used for woodland. Douglas-fir is the main woodland species on the Baumgard soil. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

Douglas-fir and western hemlock are the main woodland species on the Pheeney soil. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have

been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. Droughtiness in the surface layer of the Pheeney soil reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings on the Baumgard soil and can delay the establishment of planted Douglas-fir seedlings and the natural reforestation of western hemlock on the Pheeney soil. Because the rooting depth is restricted by the underlying bedrock, trees on the Pheeney soil are subject to occasional windthrow.

Among the common forest understory plants are cascade Oregongrape, western swordfern, vine maple, red huckleberry, and salal.

This map unit is in capability subclass VIIe.

13-Baumgard-Rock outcrop complex, 40 to 65 percent slopes. This map unit is on mountainsides and ridgetops. The native vegetation is mainly conifers. Elevation is 800 to 1,600 feet. The average annual precipitation is 55 to 65 inches. the average annual air temperature is about 48 degrees F, and the average frost-free period is 150 to 175 days.

This unit is about 55 percent Baumgard loam and 25 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.

The Baumgard soil is deep and well drained. It formed in residuum and colluvium derived dominantly from andesite. Typically, the surface layer is dark reddish brown loam about 14 inches thick. The upper 16 inches of the subsoil is reddish brown and yellowish red clay loam. The lower 15 inches is dark yellowish brown very gravelly clay loam. Fractured andesite is at a depth of about 45 inches. Depth to the andesite ranges from 40 to more than 60 inches.

Permeability is moderate in the Baumgard soil. Available water capacity is high. Effective rooting depth is 40 to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

The Rock outcrop consists mainly of exposed andesite in the form of cliffs, dikes, and boulder-sized humps.

Included in this unit are small areas of Baumgard loam that have slopes of 10 to 40 percent and small areas of Mashel and Pheeney soils. Also included are small areas of soils that are less than 40 inches deep to bedrock. Included areas make up about 20 percent of the total acreage.

This unit is used for woodland. Douglas-fir is the main woodland species on the Baumgard soil. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. The Rock outcrop hinders yarding and may cause breakage of timber when the trees are felled. Avoiding large areas of Rock outcrop results in the convergence of yarding paths and skid trails and thus in compaction of the soil. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber on the Baumgard soil. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. The areas of Rock outcrop limit the even distribution of reforestation. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, red huckleberry, western brackenfern, salmonberry, and salal.

This map unit is in capability subclass VIIe.

14-Bellingham silty clay loam. This very deep, poorly drained soil is in depressions. Drainage has

been altered by tiling and open ditches. The soil formed in alluvium and lacustrine sediments. Slopes are 0 to 3 percent. The native vegetation is mainly hardwoods and conifers. Elevation is 20 to 400 feet. The average annual precipitation is 35 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black silty clay loam about 5 inches thick. The upper part of the subsoil is gray, mottled silty clay about 9 inches thick. The lower part to a depth of 60 inches or more is gray and dark gray, mottled silty clay and clay.

Included in this unit are small areas of Norma, McKenna, Mukilteo, and Skipopa soils and Bellingham soils that have not been drained. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Bellingham soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 36 inches from October to March. Runoff is very slow, and the hazard of water erosion is slight.

This unit is used mainly for hayland, pasture, or woodland. It is also used for homesites.

The main limitation affecting hay and pasture is the high water table. All forage crops commonly produced in the survey area can be grown if the drainage system is adequate. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Rotation grazing helps to maintain the quality of forage. Applying fertilizer improves the growth of forage plants.

In undrained areas this unit is suited to woodland. On the basis of a 50-year site curve. the estimated site index for red alder is 85. The estimated growth rate of an unmanaged, even-aged stand of red alder is 92 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. The seasonal high water table limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective duff layer can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table inhibits root respiration and thus results in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the silty clay and clay subsoil and the high water table, trees are subject to frequent windthrow.

The main limitations affecting urban development are the seasonal wetness and the shrink-swell potential. A drainage system is needed if roads or buildings are constructed. A drainage system also is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Excess water can be removed by suitably designed drainage ditches. On sites for buildings and roads, the effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has a low shrink-swell potential.

The main limitations affecting septic tank absorption fields are the slow permeability and the seasonal wetness. During the rainy season, effluent from onsite sewage disposal systems may seep at points downslope.

This map unit is in capability subclass IIIw.

15-Boistfort silt loam, 5 to 20 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. The native vegetation is mainly conifers. Elevation is 300 to 1,500 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The upper part of the surface layer is dark brown silt loam about 9 inches thick, and the lower part is dark brown silty clay loam about 10 inches thick. The subsoil to a depth of 60 inches or more is dark brown and strong brown silty clay.

Included in this unit are small areas of Bunker, Katula, Lates, Olympic, and Raught soils. Also included are small areas of Boistfort silt loam that have slopes of 20 to 40 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Boistfort soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir and

western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, it is 129 for Douglas-fir and 114 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 181 cubic feet per acre per year at 60 years of age for Douglas-fir and 256 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings and delay the natural reforestation of western hemlock.

Common forest understory plants are salmonberry, western swordfern, salal, vine maple, and cascade Oregongrape.

This map unit is in capability subclass IIIe.

16-Boistfort silt loam, 20 to 40 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. The native vegetation is mainly conifers. Elevation is 300 to 1,500 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The upper part of the surface layer is dark brown silt loam about 9 inches thick, and the lower part is dark brown silty clay loam about 10 inches thick. The subsoil to a depth of 60 inches or more is dark brown and strong brown silty clay.

Included in this unit are small areas of Bunker, Katula, Lates, Olympic, and Raught soils. Also included are small areas of Boistfort silt loam that have slopes of 5 to 20 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderate in the Boistfort soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, it is 129 for Douglas-fir and 114 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 181 cubic feet per acre per year at 60 years of age for Douglas-fir and 256 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings and delay the natural reforestation of western hemlock.

Common forest understory plants are salmonberry,

western swordfern, salal, vine maple, and cascade Oregongrape.

This map unit is in capability subclass VIe.

17-Bunker gravelly silt loam, 5 to 30 percent slopes. This deep, well drained soil is on side slopes in the uplands. It formed in colluvium derived from basalt. The native vegetation is mainly conifers. Elevation is 500 to 2,200 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 175 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The surface layer is dark reddish brown gravelly silt loam about 10 inches thick. The upper 20 inches of the subsoil is dark reddish brown gravelly silt loam, and the lower 24 inches is reddish brown gravelly silt loam. Fractured basalt is at a depth of about 54 inches. Depth to the basalt ranges from 40 to 60 inches.

Included in this unit are small areas of Boistfort, Katula, Lates, Olympic, and Raught soils. Also included are small areas of Bunker gravelly silt loam that have slopes of 30 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Bunker soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 161 for Douglas-fir and 156 for western hemlock. On the basis of a 50-year site curve, it is 124 for Douglas-fir and 110 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 171 cubic feet per acre per year at 65 years of age for Douglas-fir and 248 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings and delay the natural reforestation of western hemlock.

Common forest understory plants are salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass IVe.

18-Bunker gravelly silt loam, 30 to 65 percent slopes. This deep, well drained soil is on side slopes in the uplands. It formed in colluvium derived from basalt. The native vegetation is mainly conifers. Elevation is 700 to 2,200 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 175 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The surface layer is dark reddish brown gravelly silt loam about 10 inches thick. The upper 20 inches of the subsoil is dark reddish brown gravelly silt loam, and the lower 24 inches is reddish brown gravelly silt loam. Fractured basalt is at a depth of about 54 inches. Depth to the basalt ranges from 40 to 60 inches.

Included in this unit are small areas of Boistfort, Katula, Lates, Olympic, and Raught soils. Also included are small areas of Bunker gravelly silt loam that have slopes of 5 to 30 percent. Included areas make up about 20 percent of the total acreage.

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

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 161 for Douglas-fir and 156 for western hemlock. On the basis of a 50-year site curve, it is 124 for Douglas-fir and 110 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 171 cubic feet per acre per year at 65 years of age for Douglas-fir and 248 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is the slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings and delay the natural reforestation of western hemlock.

Common forest understory plants are salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass VIe.

19-Bunker-Boistfort complex, 40 to 65 percent slopes. This map unit is on uplands. The native vegetation is mainly conifers. Elevation is 300 to 1,700 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

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

The Bunker soil is deep and well drained. It formed in colluvium derived dominantly from basalt. Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The surface layer is dark reddish brown gravelly silt loam about 10 inches thick. The upper 20 inches of the subsoil is dark reddish brown gravelly silt loam, and the lower 24 inches is reddish brown gravelly silt loam. Fractured basalt is at a depth of about 54 inches. Depth to the basalt ranges from 40 to 60 inches.

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

The Boistfort soil is very deep and well drained. It formed in residuum derived dominantly from basalt. Typically. the surface is covered with a mat of needles and twigs about 2 inches thick. The surface layer is dark brown silt loam about 9 inches thick. The subsurface layer is dark brown silty clay loam about 10 inches thick. The subsoil to a depth of 60 inches or more is dark brown and strong brown silty clay.

Permeability is moderate in the Boistfort soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

Included in this unit are small areas of Bunker and Boistfort soils that have slopes of less than 40 percent. Also included are small areas of soils in which the depth to bedrock is less than 40 inches. Included areas make up about 20 percent of the total acreage.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161 on the Bunker soil and 170 on the Boistfort soil and for western hemlock is 156 on the Bunker soil and 161 on the Boistfort soil. On the basis of a 50-year site curve, the mean site index for Douglas-fir is 124 on the Bunker soil and 129 on the Boistfort soil and for western hemlock is 110 on the Bunker soil and 114 on the Boistfort soil. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at age 65 on the Bunker soil and 181 cubic feet per acre per year at age 60 on the Boistfort soil. The highest average growth rate of an unmanaged, even-aged stand of western hemlock is 248 cubic feet per acre per year at age 50 on the Bunker soil and 256 cubic feet per acre per year at age 50 on the Boistfort soil.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads

require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings and delay the natural reforestation of western hemlock.

Common forest understory plants are salmonberry. western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass VIe.

20-Cagey loamy sand. This very deep, moderately well drained soil is on terraces. It formed in sandy glacial drift. Slopes are 0 to 4 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface layer is dark brown loamy sand about 6 inches thick. The subsoil is dark yellowish brown loamy sand about 22 inches thick. The upper 6 inches of the substratum is light olive brown fine sand, and the lower part to a depth of 60 inches or more is light olive brown, mottled fine sand.

Included in this unit are small areas of Alderwood soils on till plains and Everett, Indianola, McKenna, Nisqually, and Spanaway soils on terraces. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the Cagey soil. Available water capacity is moderate. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 18 to 30 inches from November to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for Christmas trees, hay, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

This unit is suited to year-round logging. Unsurfaced roads and skid trails are soft. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are western brackenfern, western swordfern, salal, trailing blackberry, and cascade Oregongrape.

This unit is suited to hay and pasture. The main limitation is the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and helps to control weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Rotation grazing helps to maintain the quality of forage. In most years irrigation is needed for maximum production. Sprinkler irrigation is the most suitable method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

The main limitation affecting homesites is the seasonal wetness. A subsurface drainage system is needed. The main limitations affecting septic tank absorption fields are the seasonal wetness and a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVw.

21-Cathcart gravelly loam, 3 to 15 percent slopes. This deep, well drained soil is on uplands. It formed in

glacial drift, volcanic ash, and material weathered from sandstone and siltstone. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 900 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown gravelly loam about 4 inches thick. The upper 8 inches of the subsoil is dark brown gravelly loam, and the lower 21 inches is reddish brown and yellowish red silt loam. The substratum is reddish brown, mottled clay loam about 11 inches thick. Weathered siltstone is at a depth of about 44 inches. Depth to weathered siltstone or sandstone ranges from 40 to 60 inches.

Included in this unit are small areas of Alderwood. Centralia, Everett, Indianola., and Melbourne soils on terraces. Also included are small areas of Everson.. Mukilteo, and Norma soils in depressions and small areas of Cathcart gravelly loam that have slopes of 15 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cathcart soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for hay, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western swordfern, trailing blackberry, cascade Oregongrape, salal, western brackenfern, and red huckleberry.

This unit is well suited to hay and pasture. Grasses and legumes grow well if fertilizer is applied. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. In some years irrigation is needed for maximum production. Sprinkler irrigation is the most suitable method of applying water.

The main limitation affecting homesites is the slope. On sites for buildings or roads, deep cuts may be necessary. They can expose the bedrock. The hazard of erosion is increased if the surface is bare during site development.

If the unit is used for septic tank absorption fields, the moderate permeability is a limitation. It can be overcome by increasing the size of the absorption field. The slope hinders the installation of the absorption field. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

22-Cathcart gravelly loam, 15 to 35 percent slopes. This deep, well drained soil is on uplands. It formed in glacial drift, volcanic ash, and material weathered from sandstone and siltstone. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 900 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown gravelly loam about 4 inches thick. The upper 8 inches of the subsoil is dark brown gravelly loam, and the lower 21 inches is reddish brown and yellowish red silt loam. The substratum is reddish brown, mottled clay loam about 11 inches thick. Weathered siltstone is at a depth of about 44 inches. Depth to weathered siltstone or sandstone ranges from 40 to 60 inches.

Included in this unit are small areas of Alderwood, Centralia. Everett, Indianola, and Melbourne soils on terraces. Also included are small areas of Cathcart gravelly loam that have slopes of 3 to 15 percent. Included areas make up about 20 percent of the total acreage.

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

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western swordfern, trailing blackberry, cascade Oregongrape, salal, western brackenfern, and red huckleberry.

This map unit is in capability subclass IVe.

23-Centralia silt loam, 8 to 15 percent slopes. This very deep, well drained soil is on broad ridgetops, small plateaus, and shoulder slopes. It formed in residuum derived dominantly from highly weathered, micaceous marine sandstone. The native vegetation is mainly conifers and hardwoods. Elevation is 200 to 500 feet. The average annual precipitation is 40 to 60 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. The upper part of the surface layer is very dark grayish brown silt loam about 5 inches thick, and the lower part is dark brown silt loam about 5 inches thick. The subsoil to a depth of 60 inches or more is dark brown and dark yellowish brown clay loam.

Included in this unit are small areas of Galvin and Scamman soils on alluvial fans and side slopes and Melbourne, Prather, and Salkum soils on ridgetops and shoulder slopes. Also included are small areas of Centralia silt loam that have slopes of 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Centralia soil. Available water capacity is high. 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 woodland. It is also used for homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 180. On the basis of a 50-year site curve, it is 135. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 191 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Cut slopes generally are stable, but slumping can occur. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western brackenfern, western swordfern, salal, red huckleberry, cascade Oregongrape, trailing blackberry, and vine maple.

The main limitations affecting homesites are the slope and the shrink-swell potential. Properly designing foundations and footings and diverting runoff away from buildings help to prevent the structural damage caused by shrinking and swelling. The hazard of erosion is

increased if the surface is bare during site development. Plans for homesite development should provide for the preservation of as many trees as possible. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for septic tank absorption fields, the moderate permeability is a limitation. It can be overcome by increasing the size of the absorption field. The slope hinders the installation of the absorption field. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

24-Centralia silt loam, 15 to 30 percent slopes. This very deep. well drained soil is on uplands. It formed in residuum derived dominantly from highly weathered, micaceous marine sandstone. The native vegetation is mainly conifers and hardwoods. Elevation is 200 to 500 feet. The average annual precipitation is 40 to 60 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. The upper part of the surface layer is very dark grayish brown silt loam about 5 inches thick, and the lower part is dark brown silt loam about 5 inches thick. The subsoil to a depth of 60 inches or more is dark brown and dark yellowish brown clay loam.

Included in this unit are small areas of Melbourne, Prather. and Scamman soils on shoulder slopes. Also included are small areas of Centralia silt loam that have slopes of 8 to 15 percent or 30 to 60 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderate in the Centralia soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 180. On the basis of a 50-year site curve, it is 135. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 191 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Cut slopes generally are stable, but slumping can occur. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western brackenfern, western swordfern, salal, red huckleberry, cascade Oregongrape, trailing blackberry, and vine maple.

This map unit is in capability subclass IVe.

25-Centralia silt loam, 30 to 60 percent slopes. This very deep, well drained soil is on back slopes and foot slopes in the uplands. It formed in residuum derived dominantly from highly weathered, micaceous marine sandstone. The native vegetation is mainly conifers and hardwoods. Elevation is 200 to 500 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. The upper part of the surface layer is very dark grayish brown silt loam about 5 inches thick, and the lower part is dark brown silt loam about 5 inches thick. The subsoil to a depth of 60 inches or more is dark brown and dark yellowish brown clay loam.

Included in this unit are small areas of Melbourne and Centralia soils that have slopes of 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Centralia soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 180. On the basis of a 50-year site curve, it is 135. The

highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 191 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Land slumping and road failure can occur following clearcut harvesting. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy.. invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western brackenfern, western swordfern, salal, red huckleberry, cascade Oregongrape, trailing blackberry, and vine maple.

This map unit is in capability subclass VIe.

26-Chehalis silt loam. This very deep, well drained soil is on flood plains. It formed in alluvium. Slope is 0 to 2 percent. The native vegetation is mainly conifers. Elevation is 100 to 200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically. the upper part of the surface layer is very dark grayish brown silt loam about 7 inches thick. and the lower part is dark brown silty clay loam about 18 inches thick. The subsoil is dark yellowish brown and dark brown silty clay loam about 19 inches thick. The substratum to a depth of 60 inches or more is dark brown loam.

Included in this unit are small areas of Godfrey soils in depressions, Newberg soils on natural levees, and Maytown soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Chehalis soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to March.

Most areas of this unit are used for hayland, pasture, or cropland. A few areas are used for woodland or homesites.

This unit is well suited to hay and pasture. The main management concern is the hazard of flooding. Grasses and legumes grow well if fertilizer is applied. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to all crops commonly grown in the survey area. Sweet corn, corn silage, peas, small grain, and strawberries are commonly grown on this soil. The main management concern affecting cropland is the hazard of flooding. Channeling and deposition are common along streambanks. Flooding can be controlled by dikes and levees. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. A cover crop should be planted in the fall to protect the soil from erosion during periods of flooding. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve. the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the

stand includes seed trees. natural reforestation by red alder occurs readily in cutover areas. The occasional flooding inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

The main limitation affecting homesites is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be built above the expected flood level.

This map unit is in capability subclass IIw.

27-Delphi very gravelly loam, 3 to 15 percent slopes. This deep. well drained soil is on glacial till plains. It formed in continental glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 1,000 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 195 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. The upper part of the surface layer is dark reddish brown very gravelly loam about 8 inches thick, and the lower part is dark brown very gravelly loam about 5 inches thick. The upper 18 inches of the subsoil is dark yellowish brown very gravelly silt loam, and the lower 17 inches is dark yellowish brown extremely gravelly silt loam. Glacial till is at a depth of about 48 inches. Depth to the glacial till ranges from 40 to 55 inches.

Included in this unit are small areas of Grove soils on outwash plains and Schneider soils on foothills. Also included are small areas of Delphi very gravelly loam that have slopes of 15 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate above the glacial till in the Delphi soil and very slow through the till. Available water capacity is moderate. Effective rooting depth is 40 to 55 inches. A perched seasonal high water table is at a depth of 3.5 to 4.5 feet from October to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. On the basis of a 50-year site curve, it is 129. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 183 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, salal, western brackenfern, red huckleberry, vine maple, and salmonberry.

The main limitations affecting homesites are the slope and the seasonal wetness. A drainage system should be installed on sites for buildings with basements or crawl spaces. Because of the perched water table, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. The cuts needed to provide essentially level building sites can expose the hardpan. Water flows along the top of the hardpan and can seep at the bottom of slopes.

This map unit is in capability subclass IVe.

28-Delphi very gravelly loam, 15 to 30 percent slopes. This deep, well drained soil is on glacial till plains. It formed in continental glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 1,000 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 195 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. The upper part of the surface layer is dark reddish brown very gravelly loam about 8 inches thick, and the lower part is dark brown very gravelly loam about 5 inches thick. The upper 18 inches of the subsoil is dark yellowish brown very gravelly silt loam, and the lower 17 inches is dark yellowish brown extremely gravelly silt loam. Glacial till is at a depth of about 48 inches. Depth to the glacial till ranges from 40 to 55 inches.

Included in this unit are small areas of Grove soils on outwash plains and Schneider soils on foot slopes. Also included are small areas of Delphi very gravelly loam that have slopes of 3 to 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate above the glacial till in the Delphi soil and very slow through the till. Available water capacity is moderate. Effective rooting depth is 40 to 55 inches, A perched seasonal high water table is at a depth of 3.5 to 4.5 feet from October to April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172. On the basis of a 50-year site curve, it is 129. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 183 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, salal, western brackenfern, red huckleberry, vine maple, and salmonberry.

This map unit is in capability subclass IVe.

29-Dupont muck. This very deep, poorly drained soil is in depressions on glaciated uplands. Drainage has been altered by subsurface drains and open ditches. The soil formed in organic material derived from decomposed shrubs, sedges, and grasses and in diatomaceous earth. Slopes are 0 to 1 percent. The native vegetation is mainly sedges, spirea, and rushes. Elevation is 150 to 350 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 190 days.

Typically, the surface layer is dark brown muck about 7 inches thick. The next 10 inches is dark grayish brown volcanic ash and diatomaceous earth lenses. The substratum to a depth of 60 inches or more is stratified dark reddish brown muck and white volcanic ash and diatomaceous earth.

Included in this unit are small areas of Bellingham, Mukilteo, and Tisch soils. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Dupont soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 6 to 24 inches from October to May. Runoff is very slow, and water erosion is not a hazard.

This unit is used mainly for hay and pasture. It is also used for cropland.

The main limitation affecting hay and pasture is the seasonal high water table. Most of the forage crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface during the nongrowing season. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Rotation grazing helps to maintain the quality of forage. Applying fertilizer improves the growth of forage plants.

The main limitation affecting cropland is the high water table. Most of the crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Blueberries are commonly grown on this soil. During the growing season, the water table should be lowered to a depth of about 2 to 5 feet. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface during the nongrowing season.

This map unit is in capability subclass IIIw.

30-Dystric Xerochrepts, 60 to 90 percent slopes. These moderately deep to very deep, well drained soils are on escarpments. They formed in glacial till and colluvium. The native vegetation is mainly conifers and hardwoods. Elevation is 0 to 1,000 feet. The average

annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

No single profile is typical of these soils, but in one of the more common ones. the surface is covered with a mat of leaves and twigs about 2 inches thick. The surface layer is brown *very* gravelly sandy loam about 4 inches thick. The subsoil is yellowish brown very gravelly sandy loam about 26 inches thick. The substratum to a depth of 60 inches or more is compact glacial till. Depth to the glacial till ranges from 20 to more than 60 inches.

Included in this unit are small areas of Alderwood, Everett, Hoogdal, Indianola, and Skipopa soils on ridgetops. Also included are areas of soils that are poorly drained to moderately well drained. Included areas make up about 25 percent of the total acreage.

Permeability is moderate above the dense glacial till in the Dystric Xerochrepts and very slow through the till. Available water capacity is low or moderate. Effective rooting depth is 20 to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, western redcedar, and Pacific madrone. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 150. On the basis of a 50-year site curve, it is 115. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 158 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is slope. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Land slumping and road failure can occur following clearcut harvesting. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the compact till, trees are subject to occasional windthrow.

This map unit is in capability subclass VIIe.

31-Eld loam. This deep, well drained soil is on alluvial fans and flood plains. It formed in alluvium derived dominantly from basaltic material. Slopes are 0 to 5 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 250 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is dark reddish brown loam about 7 inches thick, and the lower part is dark reddish brown loam and silt loam about 15 inches thick. The subsoil to a depth of 60 inches or more is dark brown loam and silt loam.

Included in this unit are small areas of Godfrey soils in depressions on flood plains and Maytown soils on flood plains. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Eld soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding in winter.

This unit is used for hay and pasture, cropland, or woodland. It is well suited to hay and pasture. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Applying fertilizer improves the growth of forage plants. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is well suited to cropland. It is suited to all of the crops commonly grown in the survey area. Corn silage and sweet corn are commonly grown on this soil. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Douglas-fir is the main woodland species on this unit.

Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This map unit is in capability class I.

32-Everett very gravelly sandy loam, 0 to 3 percent slopes. This very deep. somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 700 feet. The average annual precipitation is 35 to 45 inches. the average annual air temperature is about 50 degrees F. and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown very gravelly sandy loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam about 17 inches thick. The substratum to a depth of 60 inches or more is olive brown extremely gravelly loamy sand and dark grayish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Baldhill soils on terminal moraines, and Indianola and Spanaway soils on outwash plains. Also included are small areas of Everett very gravelly sandy loam that have slopes of 3 to 15 percent. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Everett soil. Available water capacity is low. 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 homesites or woodland. It is also used for hay and pasture.

This unit is well suited to homesites. Cutbanks are not stable and are subject to sloughing.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems.

Pebbles and cobbles should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 142 cubic feet per acre per year at 70 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit.

Seedling mortality is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, western brackenfern, cascade Oregongrape, red huckleberry, and trailing blackberry.

The main limitation affecting hay and pasture is the low available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least

once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This map unit is in capability subclass IVs.

33-Everett very gravelly sandy loam, 3 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 700 feet, The average annual precipitation is 35 to 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown very gravelly sandy loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam and extremely gravelly loamy sand about 17 inches thick. The substratum to a depth of 60 inches or more is olive brown extremely gravelly loamy sand and dark grayish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Baldhill soils on terminal moraines, and Indianola and Spanaway soils on outwash plains. Also included are small areas of Everett very gravelly sandy loam that have slopes of 0 to 3 percent or 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Everett soil. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland or homesites. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 142 cubic feet per acre per year at 70 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit.

Seedling mortality is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, western brackenfern, cascade Oregongrape, red huckleberry, and trailing blackberry.

This unit is suited to homesites. Cutbanks are not stable and are subject to sloughing. Pebbles and cobbles should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. Slope hinders the installation of septic tank absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVe.

34-Everett very gravelly sandy loam, 15 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 700 feet. The average annual precipitation is 35 to 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown very gravelly sandy loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam and extremely gravelly loamy sand about 17 inches thick. The substratum to a depth of 60 inches or more is olive brown extremely gravelly loamy sand and dark grayish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Baldhill soils on terminal moraines, and Indianola soils on outwash plains. Also included are small areas of Everett very gravelly sandy loam that have slopes of 3 to 15 percent or 30 to 60 percent. Included areas make up about 25 percent of the total acreage.

Permeability is rapid in the Everett soil. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the

main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 142 cubic feet per acre per year at 70 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal. western brackenfern, cascade Oregongrape, red huckleberry, and trailing blackberry.

This map unit is in capability subclass IVe.

35-Everett very gravelly sandy loam, 30 to 50 percent slopes. This very deep. somewhat excessively drained soil is on terrace escarpments. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 700 feet. The average annual precipitation is 35 to 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface is dark reddish brown very gravelly sandy loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam and extremely gravelly loamy sand about 17 inches thick. The substratum to a depth of 60 inches or more is olive brown extremely gravelly loamy sand and dark grayish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood and Kapowsin soils on terrace escarpments and Baldhill soils on terminal moraines. Also included are small areas of Everett very gravelly sandy loam that have slopes of 15 to 30 percent. Included areas make up about 25 percent of the total acreage.

Permeability is rapid in the Everett soil. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 142 cubic feet per acre per year at 70 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling mortality is the main concern in the production of timber. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, western brackenfern, cascade Oregongrape, red huckleberry, and trailing blackberry.

This map unit is in capability subclass Vle.

36-Everson clay loam. This deep, poorly drained soil is in depressions on outwash terraces. Drainage has been altered by subsurface drains and open ditches. The soil formed in alluvium or lacustrine deposits and glacial outwash. Slopes are 0 to 2 percent. The native vegetation is mainly hardwoods and conifers. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is very dark grayish brown clay loam about 6 inches thick. The upper 10 inches of the subsoil is very dark grayish brown and very dark gray, mottled clay loam and silty clay, and the

lower 14 inches is brown and reddish brown. mottled clay and clay loam. The substratum to a depth of 60 inches or more is dark gray, mottled sand.

Included in this unit are small areas of Bellingham, McKenna, and Norma soils in depressions and Cagey and Yelm soils on terraces. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the subsoil of the Everson soil and rapid in the substratum. Available water capacity is high. Effective rooting depth is about 50 inches. A seasonal high water table is at a depth of 12 to 36 inches from November to April. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used for hay and pasture. A few areas are used as woodland.

If drained, this unit is well suited to hay and pasture. The main limitation is the seasonal high water table. Most of the forage crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Rotation grazing helps to maintain the quality of forage. Applying fertilizer improves the growth of forage plants. In some years irrigation is needed. Sprinkler irrigation is the best method of applying water.

In undrained areas this unit is suited to woodland. On the basis of a 50-year site curve, the mean site index for red alder is 90. The estimated growth rate of an unmanaged, even-aged stand of red alder is 101 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. The seasonal high water table limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table inhibits root respiration and thus results in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

This map unit is in capability subclass IIIw.

37-Galvin silt loam, 0 to 5 percent slopes. This very deep. somewhat poorly drained soil is on alluvial fans. It formed in alluvium derived dominantly from shale and sandstone. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is very dark grayish brown silt loam about 7 inches thick, and the lower part is dark brown silt loam about 5 inches thick. The upper 23 inches of the subsoil is dark yellowish brown, mottled silt loam and silty clay loam, and the lower part to a depth of 60 inches or more is yellowish brown, mottled silty clay.

Included in this unit are small areas of Centralia. Melbourne, Prather, and Salkum soils on broad ridgetops and on shoulder slopes. Included areas make up about 10 percent of the total acreage.

Permeability is slow in the Galvin soil. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 6 to 18 inches from November to April. Runoff is slow and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It is also used as woodland.

This unit is suited to hay and pasture. The main limitation is the seasonal high water table. Most of the forage crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Rotation grazing helps to maintain the quality of forage. Applying fertilizer improves the growth of forage plants. In some years irrigation is needed. Sprinkler irrigation is the best method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The seasonal high water table inhibits root respiration and thus results in high seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table. trees are subject to frequent windthrow.

This map unit is in capability subclass IIIw.

38-Giles silt loam, 0 to 3 percent slopes. This deep, well drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is dark brown silt loam about 3 inches thick. The upper part of the subsoil is dark yellowish brown silt loam about 7 inches thick. The lower part is olive brown silt loam about 38 inches thick. The substratum to a depth of 60 inches or more is olive brown silt loam.

Included in this unit are small areas of Indianola, Nisqually. and Yelm soils on terraces and Norma soils in depressions. Also included are small areas of Giles silt loam that have slopes of 3 to 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Giles soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for cropland or for hay and pasture. It is also used as woodland or homesites.

This unit is well suited to cropland. No major hazards or limitations affect cropping. Corn silage, sweet corn, raspberries, strawberries, and small grain are commonly grown on this soil. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. In most years irrigation is needed for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is well suited to hay and pasture. No major hazards or limitations affect forage crops. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Applying fertilizer improves the growth of forage plants. In most years irrigation is needed for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This unit is well suited to homesites. No major hazards or limitations affect building site development. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees. and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants.

The main limitation affecting septic tank absorption

fields is the moderate permeability. This limitation can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIc.

39-Giles silt loam, 3 to 15 percent slopes. This deep, well drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is dark brown silt loam about 3 inches thick. The upper part of the subsoil is dark yellowish brown silt loam about 7 inches thick. The lower part is olive brown silt loam about 38 inches thick, The substratum to a depth of 60 inches or more is olive brown silt loam.

Included in this unit are small areas of Indianola, Nisqually, and Yelm soils on terraces. Also included are small areas of Giles silt loam that have slopes of 0 to 3 percent or 15 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Giles soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It is also used as woodland or homesites.

This unit is well suited to hay and pasture. The main management concern is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Applying fertilizer improves the growth of forage plants. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This unit is well suited to homesites. The main limitation is slope. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

The main limitations affecting septic tank absorption fields are the slope and the moderate permeability. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour. The moderate permeability can be overcome by increasing the size of the absorption fields.

This map unit is in capability subclass IIIe.

40-Giles silt loam, 15 to 30 percent slopes. This deep, well drained soil is on terrace escarpments. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is dark brown silt loam about 3 inches thick. The upper part of the subsoil is dark yellowish brown silt loam about 7 inches thick. The lower part is olive brown silt loam about 38 inches thick. The substratum to a depth of 60 inches or more is olive brown silt loam.

Included in this unit are small areas of Indianola and Yelm soils on terrace escarpments. Also included are small areas of Giles silt loam that have slopes of 3 to 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Giles soil. Available

water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. It is suited to trees. Among the trees of limited extent are red alder, western redcedar. and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This map unit is in capability subclass IVe.

41-Godfrey silty clay loam. This deep, poorly drained soil is in depressions on flood plains. Drainage has been altered by subsurface drains. The soil formed in alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly hardwoods. Elevation is 20 to 200 feet. The average annual precipitation is 40 to 50 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 180 days.

Typically, the surface layer is very dark grayish brown, mottled silty clay loam about 8 inches thick. The upper 3 inches of the subsoil is very dark gray, mottled silty clay loam, and the lower 19 inches is dark gray, mottled silty clay. The upper 12 inches of the substratum is dark gray, mottled clay loam, and the lower part to a depth of 60 inches or more is olive gray, mottled silty clay loam and dark gray, mottled silty clay.

Included in this unit are small areas of Chehalis soils on flood plains. Newburg and Puyallup soils on natural levees, and Puget and Sultan soils in depressions. Also included are small areas of Godfrey soils that have not been drained. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Godfrey soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of about 12 to 24 inches from October to March. Runoff is slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to March.

This unit is used for hay and pasture or for woodland. The main problems affecting hay and pasture are the seasonal high water table and the hazard of flooding. Most of the forage crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Rotation grazing helps to maintain the quality of forage. Applying fertilizer improves the growth of forage plants.

This unit is suited to woodland. On the basis of a 50-year site curve, the mean site index for red alder is 90. The estimated growth rate of an unmanaged, even-aged stand of red alder is 101 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. The seasonal high water table and the occasional flooding limit the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table and the occasional flooding inhibit root respiration and thus result in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

This map unit is in capability subclass IIIw.

42-Grove very gravelly sandy loam. 3 to 15 percent slopes. This very deep, somewhat excessively drained soil is on outwash plains. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 100 to 500 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface is covered with a mat of needles and twigs about 3 inches thick. The upper 6 inches of the subsoil is dark reddish brown very gravelly sandy loam, the next 15 inches is reddish brown very gravelly loamy sand, and the lower 15 inches is dark brown very gravelly sand. The substratum to a depth of 60 inches or more is dark brown extremely gravelly coarse sand.

Included in this unit are small areas of Delphi soils on till plains and Raught and Schneider soils on foothills and mountains. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the Grove soil. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 148. On the basis of a 50-year site curve, it is 112. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 156 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are salal, salmonberry. western brackenfern, western swordfern, and cascade Oregongrape.

This map unit is in capability subclass VIe.

43-Hoogdal silt loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on terrace escarpments. It formed in loess and glaciolacustrine sediment. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 50 inches. the average annual air temperature is about 51 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The upper 5 inches of the subsoil is yellowish brown silty clay loam, and the lower 15 inches is light yellowish brown, mottled silty clay. The substratum to a depth of 60 inches or more is olive gray, mottled silty clay.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains and Everett, Giles, Skipopa, and Yelm soils on terraces and terrace escarpments. Also included are small areas of Hoogdal soils that have slopes of 30 to 50 percent. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Hoogdal soil. Available water capacity is moderate. Effective rooting depth is 15 to 30 inches. A perched seasonal high water table fluctuates between depths of 18 and 24 inches from December to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167. On the basis of a 50-year site curve, it is 124. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 178 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Land slumping and road failure can occur following clearcut harvesting. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

Common forest understory plants are western swordfern, salmonberry, western brackenfern, trailing blackberry, and red huckleberry.

This map unit is in capability subclass IVe.

44-Hoogdal silt loam, 30 to 50 percent slopes. This moderately deep, moderately well drained soil is on terrace escarpments. It formed in loess and glaciolacustrine sediment. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The upper 5 inches of the subsoil is yellowish brown silty clay loam, and the lower 15 inches is light yellowish brown, mottled silty clay. The substratum to a depth of 60 inches or more is olive gray, mottled silty clay.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains and Everett, Giles, and Yelm soils on terrace escarpments. Also included are small areas of Hoogdal soils that have slopes of 15 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Hoogdal soil. Available water capacity is high. Effective rooting depth is 15 to 30 inches. A perched seasonal high water table fluctuates between depths of 18 and 24 inches from December to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167. On the basis of a 50-year site curve, it is 124. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 178 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Land slumping and road failure can occur following clearcut harvesting. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

Common forest understory plants are western swordfern, salmonberry, western brackenfern, trailing blackberry, and red huckleberry.

This map unit is in capability subclass VIe.

45-Hydraquents, tidal. These very deep, poorly drained soils are on tideland. They formed in alluvium. Slopes are 0 to 1 percent. The native vegetation is mainly salt-tolerant grasses. Elevation is 0 to 3 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

No one pedon is typical of these soils, but one of the more commonly observed ones has a surface layer of olive gray fine sandy loam about 6 inches thick. The substratum to a depth of 60 inches or more is stratified silty clay loam to fine sandy loam.

Included in this unit are small areas of water.

Permeability is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface during periods of high tide. These soils are frequently flooded for brief periods during high tides throughout the year.

This unit is used for wildlife habitat or recreation.

This map unit is in capability subclass VIIw.

46-Indianola loamy sand, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on terraces, eskers, and kames. It formed in sandy glacial drift. The native vegetation is mainly conifers. Elevation is 50 to 700 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark reddish brown loamy sand about 6 inches thick. The upper 7 inches of the subsoil is dark reddish brown loamy sand, and the lower 12 inches is dark brown loamy sand. The upper 10 inches of the substratum is dark yellowish brown sand, and the lower part to a depth of 60 inches or more is olive brown sand.

Included in this unit are small areas of Cagey. Everett, Giles, Nisqually, Spanaway, and Yelm soils on terraces. Also included are small areas of Indianola soils that have slopes of 3 to 15 percent. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Indianola soil. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture. cropland, woodland, or homesites. The main limitation affecting hay and pasture is the moderate available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing. and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

The main limitation affecting cropland is low precipitation during the growing season. Sweet corn, wheat, oats, strawberries, and raspberries are commonly grown on this soil. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, western redcedar, and western hemlock. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 151. On the basis of a 50-year site curve, it is 115. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 159 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are western brackenfern, western swordfern, salal, trailing blackberry, red huckleberry, and cascade Oregongrape.

This unit is suited to homesites. Cutbanks are not stable and are subject to sloughing. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVs.

47-Indianola loamy sand, 3 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces, eskers, and kames. It formed in sandy glacial drift. The native vegetation is mainly conifers. Elevation is 50 to 700 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark reddish brown loamy sand about 6 inches thick. The upper 7 inches of the subsoil is dark reddish brown loamy sand, and the lower 12 inches is dark brown loamy sand. The upper 10 inches of the substratum is dark yellowish brown

sand, and the lower part to a depth of 60 inches or more is olive brown sand.

Included in this unit are small areas of Everett, Giles, Nisqually, Spanaway, and Yelm soils on terraces, Also included are small areas of Indianola soils that have slopes of 0 to 3 percent or 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Indianola soil. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland. pasture, woodland. or homesites. The main limitation affecting hay and pasture is the moderate available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, western redcedar, and western hemlock. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 151. On the basis of a 50-year site curve, it is 115. The highest average growth rate of an unmanaged. even-aged stand of Douglas-fir is 159 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are western brackenfern. western swordfern, salal, trailing blackberry, red huckleberry, and cascade Oregongrape.

This unit is suited to homesites. Cutbanks are not stable and are subject to sloughing. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVs.

48-Indianola loamy sand, 15 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terrace escarpments. It formed in sandy glacial drift. The native vegetation is mainly conifers. Elevation is 50 to 700 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark reddish brown loamy sand about 6 inches thick. The upper 7 inches of the subsoil is dark reddish brown loamy sand, and the lower 12 inches is dark brown loamy sand. The upper 10 inches of the substratum is dark yellowish brown sand, and the lower part to a depth of 60 inches or more is olive brown sand.

Included in this unit are small areas of Everett, Giles, and Yelm soils on terraces. Also included are small areas of Indianola soils that have slopes of less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the Indianola soil. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder. bigleaf maple, western redcedar, and western hemlock. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 151. On the basis of a 50-year site curve, it is 115. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 159 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on

this unit, Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are western brackenfern, western swordfern, salal, trailing blackberry, red huckleberry, and cascade Oregongrape.

This map unit is in capability subclass IVs.

49-Jonas silt loam, 30 to 65 percent slopes. This deep. well drained soil is on mountain slopes. It formed in colluvium and residuum derived dominantly from andesite, which is mixed with volcanic ash in the upper part. The native vegetation is mainly conifers. Elevation is 1,800 to 2,400 feet. The average annual precipitation is 60 to 75 inches, the average air temperature is about 43 degrees F, and the average frost-free period is 130 to 160 days.

Typically, the upper part of the surface layer is very dark grayish brown silt loam about 4 inches thick, and the lower part is very dark brown very cobbly silt loam about 10 inches thick. The upper 11 inches of the subsoil is dark brown cobbly loam, and the lower part to a depth of 60 inches or more is dark brown and dark yellowish brown cobbly clay loam.

Included in this unit are small areas of Pheeney and Vailton soils on mountainsides. Included areas make up about 15 percent of the total acreage.

Permeability and available water capacity are moderate in the Jonas soil. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 158 for Douglas-fir and 160 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas-fir and 110 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 168 cubic feet per acre per year at 65 years of age for Douglas-fir and 254 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and compacts the soil. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings and the natural reforestation of western hemlock,

Common forest understory plants are vine maple, cascade Oregongrape, western brackenfern, western swordfern, and red huckleberry.

This map unit is in capability subclass VIe.

50-Kapowsin silt loam. 0 to 3 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in compact glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 600 feet. The average annual precipitation is 35 to 50 inches, the average annual air temperature is about 50 degrees F. and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 4 inches thick. The upper 14 inches of the subsoil is dark yellowish brown silt loam, the next 4 inches is dark yellowish brown, mottled loam, and the lower 8 inches is dark yellowish brown, mottled gravelly loam. The substratum to a depth of 60 inches or more is a grayish brown, weakly cemented hardpan. The hardpan is strongly compacted and crushes to gravelly loam. It is at a depth of about 20 to 30 inches.

Included in this unit are small areas of Alderwood soils on till plains, Bellingham, Dupont, McKenna, and Tisch soils in depressions, and Skipopa soils on terraces. Also included are small areas of Kapowsin silt loam that have slopes of 3 to 15 percent. Included

areas make up about 10 percent of the total acreage.

Permeability is moderate above the hardpan in the Kapowsin soil and very slow through the pan. Available water capacity is moderate. Effective rooting depth is 30 to 40 inches. A perched seasonal high water table is at a depth of 12 to 24 inches from December to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture, cropland, woodland, or homesites. The main limitations affecting hay and pasture are the seasonal high water table and the soil depth, which is limited by the hardpan. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Sweet corn, corn silage. oats. and strawberries are commonly grown on this soil. The main limitations affecting cropland are the seasonal high water table and the soil depth, which is limited by the hardpan. Artificial drainage improves the timeliness of fieldwork and increases yields of perennial crops. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table and the weakly cemented hardpan, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

The main limitation affecting homesites is the seasonal high water table. A drainage system should be installed on sites for buildings with basements or crawl spaces.

The main limitations affecting septic tank absorption fields are the wetness and the hardpan. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. The effluent from septic tank absorption fields can surface in downslope areas and thus create a health hazard.

This map unit is in capability subclass IIIw.

51-Kapowsin silt loam, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in compact glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 600 feet. The average annual precipitation is 35 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 4 inches thick. The upper 14 inches of the subsoil is dark yellowish brown silt loam, the next 4 inches is dark yellowish brown, mottled loam, and the lower 8 inches is dark yellowish brown, mottled gravelly loam. The substratum to a depth of 60 inches or more is a grayish brown, weakly cemented hardpan. It is strongly compacted and crushes to gravelly loam. It is at a depth of about 20 to 30 inches.

Included in this unit are small areas of Alderwood soils on till plains and Indianola and Skipopa soils on terraces. Also included are small areas of Kapowsin silt loam that have slopes of 0 to 3 percent or 15 to 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate above the hardpan in the Kapowsin soil and very slow through the pan. Available

water capacity is moderate. Effective rooting depth is about 20 to 30 inches. A perched seasonal high water table is at a depth of 12 to 24 inches from December to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture, woodland, or homesites. The main limitations affecting hay and pasture are the seasonal high water table and the soil depth, which is limited by the hardpan. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

The main limitation affecting homesites is the seasonal high water table. A drainage system should be installed on sites for buildings with basements or crawl spaces. The hardpan is rippable.

The main limitations affecting septic tank absorption fields are the seasonal wetness and the hardpan. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. The effluent from septic tank absorption fields can surface in downslope areas and thus create a health hazard. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

52-Kapowsin silt loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in compact glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 600 feet. The average annual precipitation is 35 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 4 inches thick. The upper 14 inches of the subsoil is dark yellowish brown silt loam, the next 4 inches is dark yellowish brown, mottled loam, and the lower 8 inches is dark yellowish brown, mottled gravelly loam. The substratum to a depth of 60 inches or more is a grayish brown, weakly cemented hardpan. It is strongly compacted and crushes to gravelly loam. It is at a depth of about 20 to 30 inches.

Included in this unit are small areas of Alderwood soils on till plains and Hoogdal and Indianola soils on terraces. Also included are small areas of Kapowsin silt loam that have slopes of 3 to 15 percent or 30 to 50 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate above the hardpan in the Kapowsin soil and very slow through the pan. Available water capacity is moderate. Effective rooting depth is about 20 to 30 inches. A perched seasonal high water table is at a depth of 12 to 24 inches from December to June. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used as woodland. A few areas are used for pasture.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the

basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy. invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

The main limitations affecting pasture are the seasonal high water table, the slope, and the soil depth, which is limited by the hardpan. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This map unit is in capability subclass IVe.

53-Kapowsin silt loam, 30 to 50 percent slopes. This moderately deep. moderately well drained soil is on escarpments on till plains. It formed in compact glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 600 feet. The average annual precipitation is 35 to 50 inches, the average air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 4 inches thick. The upper 14 inches of the subsoil is dark yellowish brown silt loam, the next 4 inches is dark yellowish brown, mottled loam, and the lower 8 inches is dark yellowish brown, mottled gravelly loam. The substratum to a depth of 60 inches or more is a grayish brown, weakly cemented hardpan. It is strongly compacted and crushes to gravelly loam. It is at a depth of about 20 to 30 inches.

Included in this unit are small areas of Alderwood soils on till plains and escarpments and Hoogdal soils on terraces. Also included are small areas of Kapowsin silt loam that have slopes of 15 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate above the hardpan in the Kapowsin soil and very slow through the pan. Available water capacity is moderate. Effective rooting depth is about 20 to 30 inches. A perched seasonal high water table is at a depth of 12 to 24 inches from December to June. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the

stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western brackenfern. western swordfern, vine maple, and salal.

This map unit is in capability subclass Vle.

54-Kapowsin stony loam. 0 to 3 percent slopes. This moderately deep. moderately well drained soil is on till plains. It formed in compact glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 400 to 550 feet. The average annual precipitation is 35 to 50 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark yellowish brown stony loam about 6 inches thick. The upper 9 inches of the subsoil is dark yellowish brown gravelly loam, and the lower 15 inches is yellowish brown, mottled gravelly loam. The substratum to a depth of 60 inches or more is a grayish brown, weakly cemented hardpan. It is strongly compacted and crushes to gravelly loam. It is at a depth of about 20 to 30 inches.

Included in this unit are small areas of Alderwood soils on till plains. Baldhill soils on terminal moraines, and Everson and Norma soils in depressions. Also included are small areas of Kapowsin stony loam that have slopes of 3 to 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate above the hardpan in the Kapowsin soil and very slow through the pan. Available water capacity is moderate. Effective rooting depth is about 20 to 30 inches. A perched seasonal high water table is at a depth of 12 to 24 inches from December to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture, woodland, or homesites. The main limitations affecting hay and pasture are the seasonal high water table, stones on the surface. and the soil depth, which is limited by the hardpan. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Because of the stones, spreading manure, mowing, and seeding are difficult. In most years irrigation is needed for maximum production.

Sprinkler irrigation is the best method of applying water.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitations affecting the harvesting of timber are the surface stones and the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The stones hinder harvesting and can cause breakage of timber when the trees are felled. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

The main limitation affecting homesites is the seasonal high water table. A drainage system should be installed on sites for buildings with basements or crawl spaces.

The main limitations affecting septic tank absorption fields are the seasonal wetness and the hardpan. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. The effluent from septic tank absorption fields can surface in downslope areas and thus create a health hazard.

This map unit is in capability subclass IVw.

55-Kapowsin stony loam, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on uplands. It formed in compact glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 400 to 550 feet. The average annual precipitation is

35 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark yellowish brown stony loam about 6 inches thick. The upper 9 inches of the subsoil is dark yellowish brown gravelly loam, and the lower 15 inches is yellowish brown, mottled gravelly loam. The substratum to a depth of 60 inches or more is a grayish brown, weakly cemented. strongly compacted hardpan. It crushes to gravelly loam. It is at a depth of about 20 to 30 inches.

Included in this unit are small areas of Alderwood soils on till plains, Baldhill soils on terminal moraines. and Everson and Norma soils in depressions. Also included are small areas of Kapowsin stony loam that have slopes of 0 to 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate above the hardpan in the Kapowsin soil and very slow through the pan. Available water capacity is moderate. Effective rooting depth is about 20 to 30 inches. A perched seasonal high water table is at a depth of 12 to 24 inches from December to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture., woodland, or homesites. The main limitations affecting hay and pasture are the seasonal high water table, stones on the surface, and the soil depth, which is limited by the hardpan. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Because of the stones, spreading manure, mowing, and seeding are difficult. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitations affecting the harvesting of timber are the surface stones and the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Stones on the surface hinder harvesting and can cause breakage of timber when the trees are felled. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western brackenfern, and western swordfern.

The main limitation affecting homesites is the seasonal high water table. A drainage system should be installed on sites for buildings with basements or crawl spaces. The hardpan is rippable.

The main limitations affecting septic tank absorption fields are the seasonal wetness and the hardpan. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. The effluent from septic tank absorption fields can surface in downslope areas and thus create a health hazard. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVe.

56-Katula very cobbly loam. 20 to 30 percent slopes. This moderately deep, well drained soil is on narrow ridgetops and back slopes in the uplands. It formed in colluvium and residuum derived from basalt. The native vegetation is mainly conifers. Elevation is 1,800 to 2,650 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is 130 to 170 days.

Typically, the surface layer is dark reddish brown very cobbly loam about 5 inches thick. The subsoil is dark brown extremely cobbly loam about 27 inches thick. Fractured basalt is at a depth of about 32 inches. Depth to the basalt ranges from 20 to 40 inches.

Included in this unit are small areas of Bunker and Lates soils and Rock outcrop on ridgetops. Also

included are small areas of Katula very cobbly loam that have slopes of 30 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Katula soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow. and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index is 143 for Douglas-fir and 145 for western hemlock. On the basis of a 50-year site curve, it is 108 for Douglas-fir and 104 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 149 cubic feet per acre per year at 65 years of age for Douglas-fir and 228 cubic feet per acre per year at 50 years of age for western hemlock. Areas on ridgetops that are subject to strong, persistent winds are less productive than other areas of this unit.

The main limitation affecting the harvesting of timber is surface cobbles, which can hinder skidding operations. This soil is suited to year-round logging. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir and noble fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and Pacific silver fir occurs periodically in cutover areas. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir and noble fir seedlings and the natural reforestation of western hemlock and Pacific silver fir. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are salal, salmonberry, cascade Oregongrape, red huckleberry, and western swordfern.

This map unit is in capability subclass VIs.

57-Katula very cobbly loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on narrow ridgetops and back slopes in the uplands. It formed in colluvium and residuum derived from basalt. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 48 degrees F. and the average frost-free period is 120 to 150 days.

Typically, the surface layer is dark reddish brown very cobbly loam about 5 inches thick. The subsoil is dark brown extremely cobbly loam about 27 inches thick. Fractured basalt is at a depth of about 32 inches. Depth to the basalt ranges from 20 to 40 inches.

Included in this unit are small areas of Bunker and Lates soils on ridgetops and shoulder slopes. Also included are small areas of Rock outcrop and small areas of Katula very cobbly loam that have slopes of 20 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Katula soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple. and Pacific silver fir. On the basis of a 100-year site curve, the mean site index is 143 for Douglas-fir and 145 for western hemlock. On the basis of a 50-year site curve, it is 108 for Douglas-fir and 104 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 149 cubic feet per acre per year at 65 years of age for Douglas-fir and 228 cubic feet per acre per year at 50 years of age for western hemlock. Areas on ridgetops that are subject to strong. persistent winds are less productive than other areas of this unit.

The main limitation affecting the harvesting of timber is slope. This soil is suited to year-round logging. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be

accomplished by planting Douglas-fir and noble fir seedlings. If the stand includes seed trees.. natural reforestation by western hemlock and Pacific silver fir occurs periodically in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir and noble fir seedlings and the natural reforestation of western hemlock and Pacific silver fir. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are salal, salmonberry, cascade Oregongrape, red huckleberry, and western swordfern.

This map unit is in capability subclass VIs.

58-Lates silt loam, 8 to 30 percent slopes. This moderately deep, well drained soil is on mountains. It formed in material weathered from basalt. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is 75 to 80 inches. the average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

Typically, the surface layer is very dark brown silt loam about 12 inches thick. The upper 10 inches of the subsoil is dark brown gravelly loam, and the lower 10 inches is dark brown gravelly silt loam. Fractured basalt is at a depth of about 32 inches. Depth to the basalt ranges from 20 to 40 inches.

Included in this unit are small areas of Bunker and Katula soils on ridgetops and shoulder slopes, soils that are less than 20 inches deep to bedrock. a poorly drained soil, and Rock outcrop. Also included are small areas of Lates silt loam that have slopes of 30 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability and available water capacity are moderate in the Lates soil. Effective rooting depth is 20 to 40 inches, Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas-fir are the main woodland species. Among the trees of limited extent are Pacific silver fir, red alder, bigleaf maple, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and 138 for Douglas-fir. On the basis of a 50-year site curve, it is 95 for western hemlock and 110 for Douglas-fir. The highest average growth rate of an unmanaged, even-aged stand is 209 cubic feet per acre per year at 50 years of age for western hemlock and 142 cubic feet per acre per year at 70 years of age for Douglas-fir.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir or noble fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and Pacific silver fir occurs periodically in cutover areas. When openings are made in the canopy. invading brushy plants can delay the establishment of planted Douglas-fir and noble fir seedlings and the natural reforestation of western hemlock and Pacific silver fir. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are salmonberry, salal, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

59-Lates silt loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on mountains. It formed in material weathered from basalt. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is 75 to 80 inches, the average annual air temperature is about 43 degrees F. and the average frost-free period is 130 to 170 days.

Typically. the surface layer is very dark brown silt loam about 12 inches thick. The upper 10 inches of the subsoil is dark brown gravelly loam, and the lower 10 inches is dark brown gravelly silt loam. Fractured basalt is at a depth of about 32 inches. Depth to the basalt ranges from 20 to 40 inches.

Included in this unit are small areas of Bunker and Katula soils on ridgetops and shoulder slopes. Also included are small areas of soils that are less than 20 inches deep to bedrock, small areas of Rock outcrop,

and small areas of Lates silt loam that have slopes of 8 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability and available water capacity are moderate in the Lates soil. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Douglas-fir are the main woodland species. Among the trees of limited extent are Pacific silver fir, red alder, bigleaf maple, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and 138 for Douglas-fir. On the basis of a 50-year site curve, it is 95 for western hemlock and 110 for Douglas-fir. The highest average growth rate of an unmanaged, even-aged stand is 209 cubic feet per acre per year at 50 years of age for western hemlock and 142 cubic feet per acre per year at 70 years of age for Douglas-fir.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir or noble fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and Pacific silver fir occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir and noble fir seedlings and the natural reforestation of western hemlock and Pacific silver fir. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are salmonberry, salal, red huckleberry, western swordfern, and western brackenfern.

This map unit is in subclass VIe.

60-Mal clay loam, 5 to 30 percent slopes. This very deep, moderately well drained soil is on foothills and mountain slopes. It formed in residuum derived dominantly from highly weathered tuffaceous marine siltstone and fine grained sandstone, which are mixed with volcanic ash in the upper part. The native vegetation is mainly conifers. Elevation is 1,800 to 2,300 feet. The average annual precipitation is 60 to 70 inches. the average air temperature is about 43 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is dark yellowish brown clay loam about 7 inches thick. The upper 9 inches of the subsoil is dark brown clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown and strong brown clay.

Included in this unit are small areas of Jonas and Vailton soils on mountainsides. Also included are small areas of Mal clay loam that have slopes of 30 to 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Mal soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 133. On the basis of a 50-year site curve, it is 110. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 134 cubic feet per acre per year at 70 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover

areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings and the natural reforestation of western hemlock.

Common forest understory plants are cascade Oregongrape, western brackenfern, vine maple, red huckleberry, and devilsclub.

This map unit is in capability subclass IVe.

61-Mal clay loam, 30 to 65 percent slopes. This very deep, moderately well drained soil is on foothills and mountainsides. It formed in residuum derived dominantly from highly weathered tuffaceous marine siltstone and fine grained sandstone. which are mixed with volcanic ash in the upper part. The native vegetation is mainly conifers. Elevation is 1,800 to 2,300 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is dark yellowish brown clay loam about 7 inches thick. The upper 9 inches of the subsoil is dark brown clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown and strong brown clay.

Included in this unit are small areas of Jonas and Vailton soils on mountainsides. Also included are small areas of Mal clay loam that have slopes of 5 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Mal soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 133. On the basis of a 50-year site curve, it is 110. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 134 cubic feet per acre per year at 70 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings and the natural reforestation of western hemlock.

Common forest understory plants are cascade Oregongrape, western brackenfern, vine maple, red huckleberry, and devilsclub.

This map unit is in capability subclass VIe.

62-Mashel loam, 5 to 30 percent slopes. This deep, moderately well drained soil is on glaciated plains and the adjacent uplands. It formed in highly weathered glacial till. The native vegetation is mainly conifers. Elevation is 900 to 1,500 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is 130 to 190 days.

Typically, the surface is covered with a mat of needles and twigs about 3 inches thick. The surface layer is dark brown loam about 8 inches thick. The upper 8 inches of the subsoil is dark brown loam, and the lower 39 inches is yellowish brown and light yellowish brown silty clay and clay loam. The substratum to a depth of 60 inches or more is grayish brown and light yellowish brown loam.

Included in this unit are small areas of Rainier soils on mountainsides and Scamman soils on terraces. Also included are small areas of Mashel loam that have slopes of 30 to 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Mashel soil. Available water capacity high. Effective rooting depth is 40 to more than 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 162. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-

aged stand of Douglas-fir is 172 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy. invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are vine maple, western swordfern, salal, red huckleberry, and trailing blackberry.

This map unit is in capability subclass IVe.

63-Mashel loam, 30 to 65 percent slopes. This deep, moderately well drained soil is on glacial plains and the adjacent uplands. It formed in highly weathered glacial till. The native vegetation is mainly conifers. Elevation is 900 to 1,500 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees F. and the average frost-free period is 130 to 190 days.

Typically, the surface is covered with a mat of needles and twigs about 3 inches thick. The surface layer is dark brown loam about 8 inches thick. The upper 8 inches of the subsoil is dark brown loam, and the lower 39 inches is yellowish brown and light yellowish brown silty clay and clay loam. The substratum to a depth of 60 inches or more is grayish brown and light yellowish brown loam.

Included in this unit are small areas of Rainier soils on mountainsides and Scamman soils on terraces. Also included are small areas of Mashel loam that have slopes of 5 to 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Mashel soil. Available water capacity is high. Effective rooting depth is 40 to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 162. On the basis of a 50-year site curve, it is 123. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 172 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy. invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are vine maple, western swordfern, salal, red huckleberry, and trailing blackberry.

This map unit is in capability subclass VIIe.

64-Maytown silt loam. This very deep, moderately well drained soil is on flood plains. It formed in alluvium derived dominantly from glacial sediments. Slope is 0 to 2 percent. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 50 to 65 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 16 inches thick. The upper 12 inches of the subsoil is brown silt loam, the next 8 inches is brown silty clay loam, and the lower part to a depth of 60 inches or more is brown, mottled silty clay loam.

Included in this unit are small areas of Chehalis soils on flood plains, Godfrey soils in depressions, and

Newberg soils on natural levees. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Maytown soil. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 30 to 40 inches from November to April. Runoff is slow., and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to April.

Most areas of this unit are used for hayland, pasture, or cropland. A few areas are used for homesites or woodland.

This unit is well suited to hay and pasture. The main limitations are the seasonal high water table and the hazard of flooding. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Sweet corn, corn silage, peas, and small grain are commonly grown on this soil. The main limitations affecting cropland are the seasonal high water table and the hazard of flooding. Channeling and deposition are common along streambanks. Flooding can be controlled by dikes and levees. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. A cover crop should be planted in the fall to protect the soil from erosion during periods of flooding. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The estimated growth rate for an unmanaged, even-aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The occasional flooding inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

The main limitation affecting homesites is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be built above the expected flood level.

The main limitations affecting septic tank absorption fields are the hazard of flooding, the seasonal wetness, and the moderately slow permeability. The moderately slow permeability and the high water table increase the likelihood that the septic tank system will fail. Backfilling the trench with sandy material and installing long absorption lines help to compensate for the moderately slow permeability.

This map unit is in capability subclass IIw.

65-McKenna gravelly silt loam, 0 to 5 percent slopes. This moderately deep, poorly drained soil is in depressions and drainageways. It formed in glacial drift. The native vegetation is mainly hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs about 3 inches thick. The surface layer is black gravelly silt loam about 9 inches thick. The upper 4 inches of the subsoil is very dark grayish brown gravelly silt loam, the next 8 inches is dark brown very gravelly silt loam, and the lower 15 inches is dark brown and dark yellowish brown, mottled very gravelly loam. The substratum to a depth of 60 inches or more is grayish brown, dense glacial till, which crushes to very gravelly loam. Depth to the glacial till ranges from 20 to 40 inches.

included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Bellingham and Norma soils in depressions, and Everett and Skipopa soils on terraces. Included areas make up about 10 percent of the total acreage.

Permeability is moderate above the dense glacial till in the McKenna soil and very slow through the till. Available water capacity is moderate. Effective rooting depth is about 20 to 40 inches. A perched seasonal high water table is near or above the surface from November to April. Runoff is ponded or very slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. A few areas are used for hay and pasture.

Red alder is the main woodland species on this unit. Among the trees of limited extent are western redcedar and western hemlock. On the basis of a 50-year site curve, the mean site index for red alder is 90. The estimated growth rate of an unmanaged, even-aged stand of red alder is 101 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table and the ponding limit the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The high water table and the ponding inhibit root respiration and thus result in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the high water table, trees are subject to frequent windthrow.

Common forest understory plants are salmonberry. devilsclub, vine maple, trailing blackberry, and sedges.

The main limitations affecting hay and pasture are the high water table and the ponding. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available. Periodic mowing helps to maintain uniform growth. discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year.

This map unit is in capability subclass VIw.

66-Melbourne silty clay loam, 5 to 20 percent slopes. This deep. well drained soil is on uplands. It formed in residuum derived dominantly from highly weathered marine siltstone. The native vegetation is mainly conifers and hardwoods. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F. and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 11 inches thick. The upper 43 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is brown clay loam.

Included in this unit are small areas of Centralia soils on uplands. Galvin soils on alluvial fans, Prather and Salkum soils on broad uplands, and Scamman soils on terraces. Also included are small areas of Melbourne silty clay loam that have slopes of 20 to 40 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Melbourne soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir. On the basis of a 50-year site curve, it is 132 for Douglas-fir and 98 for red alder. The highest average growth rate of an unmanaged, even-aged stand is 186 cubic feet per acre per year at 60 years of age for Douglas-fir and 115 cubic feet per acre per year at 40 years of age for red alder.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be

minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western brackenfern, western swordfern, salal, red huckleberry, cascade Oregongrape, and trailing blackberry.

The main limitations affecting homesites are the slope and the shrink-well potential. Cut slopes generally are stable, but sloughing can occur. The hazard of erosion is increased if the surface is bare during site development. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Properly designing foundations and footings and diverting runoff away from buildings help to prevent the structural damage caused by shrinking and swelling.

The main limitation affecting septic tank absorption fields is the moderately slow permeability. This limitation can be overcome by increasing the size of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

67-Melbourne silty clay loam, 20 to 40 percent slopes. This deep, well drained soil is on uplands. It formed in residuum derived dominantly from highly weathered marine siltstone. The native vegetation is mainly conifers and hardwoods. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 11 inches thick. The upper 43 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is brown clay loam.

Included in this unit are small areas of Centralia soils on uplands and Salkum and Scamman soils on terraces. Also included are small areas of Melbourne silty clay loam that have slopes of 5 to 20 percent or 40 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Melbourne soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir. On the basis of a 50-year site curve, it is 132 for Douglas-fir and 98 for red alder. The highest average growth rate of an unmanaged, even-aged stand is 186 cubic feet per acre per year at 60 years of age for Douglas-fir and 115 cubic feet per acre per year at 40 years of age for red alder.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western brackenfern, western swordfern, salal, red huckleberry, cascade Oregongrape, and trailing blackberry.

This map unit is in capability subclass VIe.

68-Melbourne silty clay loam, 40 to 65 percent slopes. This deep, well drained soil is on uplands. It formed in residuum and colluvium derived dominantly from highly weathered marine siltstone. The native vegetation is mainly conifers and hardwoods. Elevation is 200 to 600 feet. The average annual precipitation is

45 to 60 inches. the average air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 11 inches thick. The upper 43 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is brown clay loam.

Included in this unit are small areas of Centralia soils on uplands. Also included are small areas of Melbourne silty clay loam that have slopes of 20 to 40 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Melbourne soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir. On the basis of a 50-year site curve, it is 132 for Douglas-fir and 98 for red alder. The highest average growth rate of an unmanaged, even-aged stand is 186 cubic feet per acre per year at 60 years of age for Douglas-fir and 115 cubic feet per acre per year at 40 years of age for red alder.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided. Slumping and road failure can occur following clearcut harvesting.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are western brackenfern, western swordfern, salal, red huckleberry, cascade Oregongrape, and trailing blackberry. This map unit is in capability subclass VIIe.

69-Mukilteo muck. This very deep, very poorly drained soil is in upland depressions. It formed in organic material derived from sedges. Slopes are 0 to 2 percent. The native vegetation is mainly sedges and rushes. Elevation is 50 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark yellowish brown and dark reddish brown muck about 6 inches thick. Below this to a depth of 60 inches or more is dark reddish brown mucky peat.

Included in this unit are small areas of Shalcar and Mukilteo soils in upland depressions that have been artificially drained. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Mukilteo soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface from October to April. Runoff is ponded, and water erosion is not a hazard.

This unit is used for wildlife habitat or woodland. Red alder is the main woodland species. On the basis of a 50-year site curve, the estimated mean site index for red alder is 85. The highest average growth rate for red alder is about 90 cubic feet per acre per year at age 40 provided a fully stocked stand is established.

The main limitation affecting the harvesting of timber is the extreme muddiness caused by the extended periods of wetness. Logging roads are typically not located on this unit. Rock for road construction is not readily available. The seasonal high water table and the ponding limit the use of equipment to dry periods.

Seedling mortality and seedling establishment are the main concerns in the production of timber. Reforestation can be accomplished by planting western redcedar. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. The seasonal high water table inhibits root respiration and thus results in a low seedling survival rate. Because the rooting depth is restricted by the seasonal high water table, trees are frequently subject to windthrow.

This map unit is in capability subclass VIIw.

70-Mukilteo muck, drained. This very deep, very poorly drained soil is in upland depressions. Drainage has been altered by subsurface drains and open

ditches. The soil formed in organic material derived dominantly from sedges. Slopes are 0 to 2 percent. The native vegetation is mainly sedges and rushes. Elevation is 50 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark yellowish brown and dark reddish brown muck about 6 inches thick. Below this to a depth of 60 inches or more is dark reddish brown mucky peat.

Included in this unit are small areas of Mukilteo and Shalcar soils in upland depressions that have not been artificially drained. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Mukilteo soil. Available water capacity is high. Effective rooting depth is limited by a controlled water table that is at a depth of about 18 to 36 inches during the growing season. Runoff is slow, and water erosion is not a hazard.

This unit is used for cropland, hayland, or pasture. Blueberries are commonly grown on this soil. Most of the crops commonly produced in the survey area can be grown if an adequate drainage system is installed. The main limitation affecting cropland is the high water table. During the growing season, the water table should be lowered to a depth to about 2 to 5 feet. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface during the nongrowing season.

All forage crops commonly produced in the survey area can be grown if the drainage system is adequate. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface during the nongrowing season. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year.

This map unit is in capability subclass IIw.

71-Newberg fine sandy loam. This very deep, well drained soil is on natural levees on flood plains. It formed in alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 100 to 500 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the upper part of the surface layer is very dark grayish brown fine sandy loam about 8 inches thick, and the lower part is dark brown fine sandy loam about 9 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 Chehalis, Eld, and Maytown soils on flood plains and Godfrey soils in depressions. Also included are small areas of Newberg soils that have a loam surface layer. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Newberg soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from December to March.

Most areas of this unit are used for cropland, hayland, or pasture. A few areas are used for woodland or homesites.

This unit is well suited to crops. Sweet corn, corn silage, oats, and strawberries are commonly grown. The main limitation affecting cropland is the hazard of flooding. Channeling and deposition are common along streambanks. Flooding can be controlled by dikes. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. Irrigation is needed for maximum yields. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

The main limitation affecting hay and pasture is the hazard of flooding. Grasses and legumes grow well if fertilizer is applied. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Rotation grazing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The estimated growth rate of an unmanaged, even-

aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The occasional flooding inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

The main problem affecting homesites is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be built above the expected flood level.

The main problems affecting septic tank absorption fields are the hazard of flooding and a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage.

This map unit is in capability subclass IIw.

72-Newberg loam. This very deep, well drained soil is on natural levees on flood plains. It formed in alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 100 to 500 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the upper part of the surface layer is very dark grayish brown loam about 8 inches thick. and the lower part is dark brown fine sandy loam about 9 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 Chehalis. Eld, and Maytown soils on flood plains and Godfrey soils in depressions. Also included are small areas of Newberg soils that have a fine sandy loam surface layer. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Newberg soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from December to March.

Most areas of this unit are used for cropland, hayland, or pasture. A few areas are used for woodland or homesites.

This unit is well suited to cropland. Sweet corn, corn silage, oats, and strawberries are commonly grown. The main limitation affecting cropland is the hazard of flooding. Channeling and deposition are common along streambanks. Flooding can be controlled by the use of dikes. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content. fertility, and tilth. Irrigation is needed for maximum yields. Sprinkler irrigation is the best method of applying water.

The main problem affecting hay and pasture is the hazard of flooding. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red

alder occurs readily in cutover areas. The occasional flooding inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

The main problem affecting homesites is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be built above the expected flood level.

The main problems affecting septic tank absorption fields are the hazard of flooding and a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIw.

73-Nisqually loamy fine sand, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in sandy glacial outwash. The native vegetation is mainly prairie grasses, ferns, and mosses. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 55 inches, the average air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is black loamy fine sand about 5 inches thick, and the lower part is very dark gray and very dark grayish brown loamy fine sand about 26 inches thick. The substratum to a depth of 60 inches or more is light olive brown loamy sand.

Included in this unit are small areas of Cagey, Giles, Indianola, Spanaway, and Yelm soils on terraces and Everson and Norma soils in depressions. Also included are small areas of Nisqually loamy fine sand that have slopes of 3 to 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the surface layer of the Nisqually soil and very rapid in the substratum. Available water capacity is moderate. 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 hayland, pasture, or homesites. It is also used as woodland.

The main limitation affecting hay and pasture is the moderate available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Periodic mowing helps to maintain uniform growth. discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

The main limitation affecting cropland is the moderate available water capacity. Sweet corn, wheat, oats, strawberries, and raspberries are commonly grown on this soil. Broccoli is grown in a few areas (fig. 1). Returning crop residue to the soil and growing cover crops help to maintain the organic matter content, fertility, and tilth. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is the best method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167. On the basis of a 50-year site curve, it is 125. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 178 cubic feet per acre per year at 60 years of age.

The unit is suited to year-round logging. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

This unit is suited to homesites. Cutbanks are not stable and are subject to sloughing. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. A plant cover can be established and maintained by proper fertilizing, seeding, mulching, and shaping of the slopes.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage

Figure 1.-Broccoli in an area of Nisqually loamy fine sand, 0 to 3 percent slopes.

systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVs.

74-Nisqually loamy fine sand, 3 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in sandy glacial outwash. The native vegetation is mainly prairie grasses, ferns, and mosses. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is black loamy fine sand about 5 inches thick, and the lower part is very dark gray and very dark grayish brown loamy

fine sand about 26 inches thick. The substratum to a depth of 60 inches or more is light olive brown loamy sand.

Included in this unit are small areas of Giles, Indianola. Spanaway, and Yelm soils on terraces. Also included are small areas of Nisqually loamy fine sand that have slopes of 0 to 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the surface layer of the Nisqually soil and very rapid in the substratum. Available water capacity is moderate. 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 hayland, pasture. or homesites. It is also used as woodland.

The main limitation affecting hay and pasture is the moderate available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167. On the basis of a 50-year site curve, it is 125. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 178 cubic feet per acre per year at 60 years of age.

This soil is suited to year-round logging. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. if the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

This unit is suited to homesites. Cutbanks are not stable and are subject to sloughing. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. A plant cover can be established and maintained by fertilizing, seeding, mulching, and shaping of the slopes.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. The slope hinders installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass lVe.

75-Norma fine sandy loam. This very deep, poorly drained soil is in depressions on till plains. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly sedges, rushes, and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 55 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is very dark grayish brown fine sandy loam about 7 inches thick. The subsoil is dark grayish brown, mottled fine sandy loam about 18 inches thick. The substratum to a depth of 60 inches or more is olive gray, mottled sandy loam.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Everson soils in depressions, and Cagey and Everett soils on terraces. Also included are small areas of Norma silt loam. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Norma soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is near or above the surface from November to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture.. or woodland. The main limitations affecting hay and pasture are the seasonal high water table and the ponding. Some areas have been partially drained, but adequate drainage systems have not been maintained. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Proper

stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year.

This unit is suited to woodland. On the basis of a 50-year site curve, the mean site index for red alder is 90. The estimated growth rate of an unmanaged, even-aged stand of red alder is 101 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the extreme muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table and the ponding limit the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The ponding and the seasonal high water table inhibit root respiration and thus result in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the seasonal high water table. trees are subject to frequent windthrow.

This map unit is in capability subclass VIw.

76-Norma silt loam. This very deep, poorly drained soil is in depressions on till plains. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly sedges, rushes, and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 55 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is dark grayish brown, mottled sandy loam about 22 inches thick. The substratum to a depth of 60 inches or more is olive gray, mottled sandy loam.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Everson soils in depressions. and Cagey and Everett soils on terraces. Also included are small areas of Norma fine sandy loam. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Norma soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is near or above the surface from November to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for hayland, pasture. or woodland. The main limitations affecting hay and pasture are the seasonal high water table and the ponding. Some areas have been partially drained, but adequate drainage systems have not been maintained. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation. and restricted grazing during wet periods help to keep the pasture in good condition. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year.

This unit is suited to woodland. On the basis of a 50year site curve, the mean site index for red alder is 90. The estimated growth rate of an unmanaged, even-aged stand of red alder is 101 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table and the ponding limit the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the

production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The ponding and the seasonal high water table inhibit root respiration and thus result in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

This map unit is in capability subclass VIw.

77-Olympic silt loam, 5 to 20 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from basalt. The native vegetation is mainly conifers. Elevation is 200 to 1,600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown and dark reddish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is yellowish red silty clay loam, and the lower part to a depth of 60 inches or more is yellowish red clay.

Included in this unit are small areas of Boistfort, Bunker, Centralia, Melbourne, and Raught soils on uplands and Galvin soils on alluvial fans. Also included are small areas of Olympic silt loam that have slopes of 20 to 40 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Olympic soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 175. On the basis of a 50-year site curve, it is 133. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 186 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction generally is available at a depth of about 5 to 10 feet. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass IIIe.

78-Olympic silt loam, 20 to 40 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from basalt. The native vegetation is mainly conifers. Elevation is 200 to 1,600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown and dark reddish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is yellowish red silty clay loam, and the lower part to a depth of 60 inches or more is yellowish red clay.

Included in this unit are small areas of Boistfort, Bunker, Centralia, Melbourne, and Raught soils on uplands. Also included are small areas of Olympic silt loam that have slopes of 5 to 20 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Olympic soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 175. On the basis of a 50-year site curve, it is 133. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 186 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction.

Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction generally is available at a depth of about 5 to 10 feet. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass VIe.

79-Pheeney gravelly loam, 5 to 30 percent slopes. This moderately deep. well drained soil is on upland benches, ridge crests, and mountain slopes. It formed in residuum and colluvium derived dominantly from andesite, which is mixed with volcanic ash in the upper part. The native vegetation is mainly conifers. Elevation is 1,500 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick, and the lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Vailton soils on mountainsides. Also included are small areas of Pheeney gravelly loam that have slopes of 30 to 65 percent and small areas of Rock outcrop. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple. and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock. Areas on ridgetops that are subject to strong, persistent winds are less productive than other areas of this unit.

The main limitations affecting the harvesting of timber are occasional snowpack and the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock occurs readily in cutover areas. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are western brackenfern, vine maple, cascade Oregongrape, western swordfern, and red huckleberry.

This map unit is in capability subclass IVe.

80-Pheeney gravelly loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on mountainsides. It formed in residuum and colluvium derived dominantly from andesite, which is mixed with volcanic ash in the upper part. The native vegetation is mainly conifers. Elevation is 1,500 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the

average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick, and the lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Vailton soils on mountainsides. Also included are small areas of Pheeney gravelly loam that have slopes of 5 to 30 percent and small areas of Rock outcrop. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock occurs readily in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are western brackenfern, vine maple. cascade Oregongrape, western swordfern, and red huckleberry.

This map unit is in capability subclass VIe.

81-Pheeney-Baumgard complex, 30 to 65 percent slopes. This map unit is on uplands and mountainsides. The native vegetation is mainly conifers. Elevation is 1,200 to 1,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 43 to 48 degrees F, and the average frost-free period is 130 to 170 days.

This unit is about 40 percent Pheeney gravelly loam and 30 percent Baumgard loam. The components of this unit are so intricately intermingled that it is not practical to map them separately at the scale used.

The Pheeney soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite. Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick, and the lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

The Baumgard soil is deep and well drained. It formed in residuum and colluvium derived dominantly from andesite. Typically, the surface layer is dark reddish brown loam about 14 inches thick. The upper 16 inches of the subsoil is reddish brown and yellowish red clay loam, and the lower 15 inches is dark yellowish brown very gravelly clay loam. Fractured andesite is at a depth of about 45 inches. Depth to the andesite ranges from 40 to 60 inches.

Permeability is moderate in the Baumgard soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

Included in this unit are small areas of Mashel soils on glacial plains and Jonas, Rainier, and Vailton soils on mountainsides. Included areas make up about 30 percent of the total acreage.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species on the Pheeney soil. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock.

Douglas-fir is the main woodland species on the Baumgard soil. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve. the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged. even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment and seedling mortality on the Pheeney soil and seedling establishment on the Baumgard soil are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate on the Pheeney soil. When openings are made in the canopy of stands, invading brushy plants can prevent the establishment of Douglas-fir seedlings on both soils and delay the natural reforestation of western hemlock on the Pheeney soil. Because the rooting depth is restricted in the Pheeney soil by the underlying bedrock, trees are subject to occasional windthrow.

Common forest understory plants are cascade Oregongrape, western swordfern, vine maple, red huckleberry, and salal.

This map unit is in capability subclass Vle.

82-Pheeney-Rock outcrop complex, 40 to 65 percent slopes. This map unit is on mountainsides and ridgetops. The native vegetation is mainly conifers. Elevation is 1,700 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

This unit is about 50 percent Pheeney gravelly loam and 25 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.

The Pheeney soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite. Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick, and the lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

The Rock outcrop consists mainly of exposed andesite occurring as cliffs, dikes, and boulder-sized humps.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Vailton soils on mountainsides. Also included are small areas of soils that are more than 40 inches deep to bedrock and small areas of Pheeney soils that have slopes of 65 to 90 percent. Included areas make up about 25 percent of the total acreage.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species on the Pheeney soil. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock. Areas on ridgetops that are subject to strong, persistent winds are less

productive than other areas of this unit.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. The Rock outcrop can hinder yarding and cause breakage of timber when the trees are felled. Avoiding large areas of Rock outcrop results in the convergence of yarding paths and skid trails and thus in compaction of the soil. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment and seedling mortality are the main concerns in the production of timber on the Pheeney soil. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Droughtiness in the surface layer reduces the seedling survival rate. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock. The Rock outcrop limits the even distribution of reforestation.

Common forest understory plants are western brackenfern, vine maple, cascade Oregongrape, western swordfern, and red huckleberry.

This map unit is in capability subclass VIIe.

83-Pheeney-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on mountainsides. The native vegetation is mainly conifers. Elevation is 1,700 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

This unit is about 50 percent Pheeney gravelly loam and 25 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.

The Pheeney soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite. Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick, and the lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

The Rock outcrop consists mainly of areas of exposed andesite occurring as cliffs, dikes, and boulder-sized humps.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Vailton soils on mountainsides. Also included are small areas of soils that are more than 40 inches deep to bedrock and small areas of Pheeney soils that have slopes of 40 to 65 percent. Included areas make up about 25 percent of the total acreage.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species on the Pheeney soil. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. Cable yarding systems generally are used on this unit. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. The rock outcrop hinders yarding and may cause breakage of timber when the trees are felled. Avoiding large areas of Rock outcrop results in the convergence of yarding paths and skid trails and thus in compaction of the soil. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are

protected by a plant cover or adequate water bars are provided. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and seedling mortality are the main concerns in the production of timber on the Pheeney soil. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Droughtiness in the surface layer reduces the seedling survival rate. Because the rooting depth is restricted by the underlying bedrock, trees are subject to occasional windthrow. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock. The Rock outcrop limits the even distribution of reforestation.

Common forest understory plants are western brackenfern, vine maple, cascade Oregongrape, western swordfern, and red huckleberry.

This map unit is in capability subclass VIIe.

84-Pilchuck loamy sand. This very deep, somewhat excessively drained soil is on flood plains. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 20 to 600 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is very dark brown loamy sand about 6 inches thick. The upper 18 inches of the substratum is dark brown fine sand, the next 8 inches is dark brown loamy fine sand, and the lower part to a depth of 60 inches or more is very dark grayish brown fine sand.

Included in this unit are small areas of Puget and Sultan soils in depressions and Newberg and Puyallup soils on natural levees. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the Pilchuck soil. Available water capacity is low. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of about 24 to 48 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to April.

This unit is used mainly for woodland. It is also used for hay and pasture.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, western redcedar, western hemlock, and black cottonwood. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 152. On the basis of a 50-year site curve, it is 114. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 161 cubic feet per acre per year at 60 years of age.

The main hazard affecting the harvesting of timber is the flooding, which limits the use of equipment to dry periods. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The flooding inhibits root respiration and thus results in high seedling mortality. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are vine maple, salmon berry, western swordfern, western brackenfern, and common snowberry.

The main limitations affecting hay and pasture are the low available water capacity, low fertility, and the flooding. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Channeling and deposition are common along streambanks. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This map unit is in capability subclass IVw.

85-Pits, gravel. This map unit consists of open excavations from which soil and the underlying rounded glacial pebbles and stones have been removed. It supports little or no vegetation. The excavated gravelly material is used as ballast and as topdressing on logging roads.

This map unit is in capability subclass VIIIs.

86-Prather silty clay loam, 3 to 8 percent slopes. This very deep, moderately well drained soil is on upland terraces. It formed in residuum derived dominantly from highly weathered, ancient glacial drift. The native vegetation is mainly conifers. Elevation is 200 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is very dark grayish brown silty clay loam about 5 inches thick, and the lower part is dark brown silty clay loam about 7 inches thick. The upper 17 inches of the subsoil is dark brown silty clay, the next 13 inches is dark brown, mottled silty clay, and the lower part to a depth of 60 inches or more is yellowish brown, mottled clay.

Included in this unit are small areas of Galvin soils on alluvial fans and Salkum and Scamman soils on terraces. Also included are small areas of Prather silty clay loam that have slopes of 8 to 20 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the subsoil in the Prather soil and slow in the lower part. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of about 18 to 36 inches from November to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for hayland, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, bigleaf maple, and western hemlock. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 156. On the basis of a 50-year site curve, it is 120. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 165 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

Common forest understory plants are salal, cascade Oregongrape, vine maple, red huckleberry, western swordfern, and western brackenfern.

The main limitation affecting hay and pasture is the seasonal high water table. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

The main limitations affecting homesites are the shrink-swell potential and the seasonal wetness. The wetness can be reduced by installing drains around the footings. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has a low shrink-swell potential.

The main limitations affecting septic tank absorption fields are the slow permeability and the seasonal wetness, which increase the likelihood that the disposal system will fail. The slow permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIe.

87-Prather silty clay loam, 8 to 20 percent slopes. This very deep, moderately well drained soil is on upland terraces. It formed in residuum derived dominantly from highly weathered, ancient glacial drift. The native vegetation is mainly conifers. Elevation is 200 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is very dark grayish brown silty clay loam about 5 inches thick,

and the lower part is dark brown silty clay loam about 7 inches thick. The upper 17 inches of the subsoil is dark brown silty clay, the next 13 inches is dark brown, mottled silty clay, and the lower part to a depth of 60 inches or more is yellowish brown, mottled clay.

Included in this unit are small areas of Centralia, Melbourne, Salkum, and Scamman soils on terraces. Also included are small areas of Prather silty clay loam that have slopes of 3 to 8 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the subsoil in the Prather soil and slow in the lower part. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of about 18 to 36 inches from November to April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for woodland. It is also used for hayland, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western redcedar, bigleaf maple, and western hemlock. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 156. On the basis of a 50-year site curve, it is 120. The highest average growth rate of an unmanaged. even-aged stand of Douglas-fir is 165 cubic feet per acre per year at 60 years of age,

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

Common forest understory plants are salal, cascade Oregongrape, vine maple, red huckleberry, western swordfern, and western brackenfern.

The main limitation affecting hay and pasture is the seasonal high water table. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

The main limitations affecting homesites are the shrink-swell potential, the seasonal wetness, and the slope. The wetness can be reduced by installing drains around the footings. Preserving the existing plant cover during construction helps to control erosion. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has a low shrink-swell potential.

The main limitations affecting septic tank absorption fields are the slow permeability and the seasonal wetness, which increase the likelihood that the disposal system will fail. The slow permeability can be overcome by increasing the size of the absorption fields. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

88-Puget silt loam. This very deep, poorly drained soil is in depressions on flood plains. Drainage has been altered by subsurface drains. The soil formed in alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly grasses and sedges. Elevation is 10 to 100 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

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

Included in this unit are small areas of Newberg and Puyallup soils on natural levees and Pilchuck, Semiahmoo, and Sultan soils on flood plains. Also included are small areas of Puget soils that have not

been artificially drained. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Puget soil. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of about 12 to 36 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to April.

Most areas of this unit are used for hayland, pasture, or cropland. A few areas are used as woodland.

The main limitations affecting hay and pasture are the seasonal high water table and the flooding. All forage crops commonly produced in the survey area can be grown if the drainage system is adequate. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Rotation grazing helps to maintain the quality of forage. Applying fertilizer improves the growth of forage plants. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Sweet corn, corn silage, and small grain are commonly grown on this soil. The main limitations affecting cropland are the high water table and the flooding. The flooding can be controlled by dikes and levees. During the growing season, the water table should be lowered to a depth of about 2 to 5 feet. Most of the crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Undrained and unprotected areas are suited to woodland. On the basis of a 50-year site curve, the mean site index for red alder is 90. The estimated growth rate of an unmanaged, even-aged stand of red alder is 101 cubic feet per acre per year at 40 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table and the flooding limit the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The seasonal high water table and the flooding inhibit root respiration and thus result in high seedling mortality. When openings are made in the canopy, invading brushy plants can delay the establishment of western redcedar seedlings. Seedling mortality may be high where flooding occurs. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

This map unit is in capability subclass IIw.

89-Puyallup silt loam. This deep, well drained soil is on flood plains. It formed in alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly conifers and deciduous trees. Elevation is 20 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the upper part of the surface layer is very dark grayish brown silt loam about 10 inches thick, and the lower part is dark brown loamy fine sand and fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is very dark gray sand.

Included in this unit are small areas of Newberg and Pilchuck soils on flood plains and Puget and Sultan soils in depressions. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Puyallup soil. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to April.

This unit is used mainly for hayland, pasture, or cropland. It is also used as woodland.

This unit is well suited to hay and pasture. The main limitations are the flooding and the moderate available water capacity. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and

controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is well suited to cropland. Corn silage, sweet corn, rhubarb, and small grain are commonly grown. The main hazard affecting cropland is the flooding, Channeling and deposition are common along streambanks. The flooding can be controlled by dikes and levees. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 167. On the basis of a 50-year site curve, it is 125. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 178 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The flooding limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The flooding inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This map unit is in capability subclass IIw.

90-Rainier clay loam, 5 to 30 percent slopes. This deep, moderately well drained soil is on mountainsides. It formed in residuum and colluvium derived from breccia and glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 700 to 1,700 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 130 to 150 days.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. The upper 6 inches of the subsoil is very dark grayish brown clay loam, and the lower 31 inches is dark grayish brown clay loam and dark brown clay. Slightly weathered breccia is at a depth of about 45 inches. Depth to the breccia ranges from 40 to 60 inches.

Included in this unit are small areas of Baumgard and Pheeney soils on mountainsides, Mashel soils on glacial uplands, and Scamman soils on terraces. Also included are small areas of Rainier clay loam that have slopes of 30 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Rainier soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table is at a depth of about 36 to 42 inches from November to April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 127. On the basis of a 50-year site curve, it is 95. The highest growth rate of an unmanaged. even-aged stand of Douglas-fir is 125 cubic feet per acre per year at 70 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, vine maple, cascade Oregongrape, red huckleberry, and western swordfern.

This map unit is in capability subclass IVe.

91-Rainier clay loam, 30 to 65 percent slopes. This deep, moderately well drained soil is on mountainsides. It formed in residuum and colluvium derived from breccia and glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 700 to 1,700 feet. The average annual precipitation is 45 to 55 inches. the average annual air temperature is about 50 degrees F, and the average frost-free period is 130 to 150 days.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. The upper 6 inches of the subsoil is very dark grayish brown clay loam, and the lower 31 inches is dark grayish brown clay loam and dark brown clay. Slightly weathered breccia is at a depth of about 45 inches. Depth to the breccia ranges from 40 to 60 inches.

Included in this unit are small areas of Baumgard and Pheeney soils on mountainsides, Mashel soils on glacial uplands, and Scamman soils on terraces. Also included are small areas of Rainier clay loam that have slopes of 5 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Rainier soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table is at a depth of about 36 to 42 inches from November to April. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 127. On the basis of a 50-year site curve, it is 95. The highest growth rate of an unmanaged, even-aged stand of Douglas-fir is 125 cubic feet per acre per year at 70 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings.

Common forest understory plants are salal, vine maple, cascade Oregongrape, red huckleberry, and western swordfern.

This map unit is in capability subclass VIe.

92-Rainier-Rock outcrop complex, 20 to 40 percent slopes. This map unit is on mountainsides. The native vegetation is mainly conifers and hardwoods. Elevation is 700 to 1,700 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 130 to 150 days.

This unit is about 50 percent Rainier loam and 25 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.

The Rainier soil is deep and moderately well drained. It formed in residuum and colluvium derived dominantly from breccia and glacial till. Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. The upper 6 inches of the subsoil is very dark grayish brown clay loam, and the lower 31 inches is dark grayish brown clay loam and dark brown clay. Slightly weathered breccia is at a depth of about 45 inches. Depth to the breccia ranges from 40 to 60 inches.

Permeability is moderately slow in the Rainier soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table is at a depth of about 36 to 42 inches from November to April. Runoff is medium, and the hazard of water erosion is moderate.

The Rock outcrop consists mainly of exposed breccia occurring as cliffs, dikes, and boulder-sized humps.

Included in this unit are small areas of Baumgard and Pheeney soils on mountainsides, Mashel soils on glacial uplands, and Scamman soils on terraces. Also included are small areas of soils that are less than 40 inches deep to bedrock. Included areas make up about 25 percent of the total acreage.

This unit is used as woodland. Douglas-fir is the

main woodland species on the Rainier soil. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 127. On the basis of a 50-year site curve, it is 95. The highest growth rate of an unmanaged, even-aged stand of Douglas-fir is 125 cubic feet per acre per year at 70 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. The Rock outcrop hinders yarding and may cause breakage of timber when the trees are felled. Avoiding large areas of Rock outcrop results in the convergence of yarding paths and skid trails and thus in compaction of the soil. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber on the Ranier soil. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings. The Rock outcrop limits the even distribution of reforestation.

Common forest understory plants are salal, vine maple, cascade Oregongrape, red huckleberry, and western swordfern.

This map unit is in capability subclass VIe.

93-Raught silt loam, 5 to 30 percent slopes. This very deep, well drained soil is on shoulder slopes in the uplands. It formed in material weathered from basalt. The native vegetation is mainly conifers. Elevation is 200 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F. and the average frost-free period is 150 to 200 days.

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

Included in this unit are small areas of Boistfort, Bunker, Centralia, Melbourne, and Olympic soils on uplands. Also included are small areas of Raught silt loam that have slopes of 30 to 65 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Raught soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 162 for western hemlock. On the basis of a 50-year site curve, it is 131 for Douglas-fir and 115 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 187 cubic feet per acre per year at 60 years of age for Douglas-fir and 258 cubic feet per acre at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction generally is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. Also, natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings and can delay the natural reforestation of western hemlock.

Common forest understory plants are salmonberry, salal, cascade Oregongrape, vine maple, and western swordfern.

This map unit is in capability subclass IVe.

94-Raught silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on shoulder slopes in the

uplands. It formed in material weathered from basalt. The native vegetation is mainly conifers. Elevation is 200 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F. and the average frost-free period is 150 to 200 days.

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

Included in this unit are small areas of Boistfort, Centralia, Melbourne, and Olympic soils on uplands. Also included are small areas of Raught silt loam that have slopes of 5 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Raught soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 162 for western hemlock. On the basis of a 50-year site curve, it is 131 for Douglas-fir and 115 for western hemlock. The highest growth rate of an unmanaged, even-aged stand is 187 cubic feet per acre per year at 60 years of age for Douglas-fir and 258 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. if the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock.

Common forest understory plants are salmonberry, salal, cascade Oregongrape, vine maple, and western swordfern.

This map unit is in capability subclass VIe.

95-Riverwash. This map unit is on flood plains along streams. It is frequently flooded and is commonly altered by severe erosion and deposition. It formed in recent alluvium consisting of sand, gravel, cobbles, and stones. It is very deep and somewhat excessively drained. It supports little or no vegetation. Elevation is 30 to 1,000 feet. The average annual precipitation is 35 to 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

The texture of the soil material and the content of gravel, cobbles, and stones vary widely within short distances.

Included in this unit are small areas of sandbars. Also included are areas of Pilchuck soils on flood plains. Included areas make up about 30 percent of the total acreage.

Some areas of this unit are suitable sources of sand and gravel.

This map unit is in capability subclass VIIIw.

96-Rock outcrop-Pheeney complex, 40 to 90 percent slopes. This map unit is on mountainsides and ridgetops. The native vegetation is mainly conifers. Elevation is 1,700 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 43 degrees F, and the average frost-free period is 130 to 170 days.

This unit is about 50 percent Rock outcrop and 25 percent Pheeney gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

The Rock outcrop consists mainly of exposed andesite occurring as cliffs, dikes, and boulder-sized humps.

The Pheeney soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite. Typically, the upper part of the surface layer is black gravelly loam about 6 inches thick, and the lower part is very dark brown gravelly silt loam about 4 inches thick. The subsoil is dark yellowish brown very gravelly silt loam about 20 inches thick. Fractured andesite is at a depth of about 30 inches. Depth to the andesite ranges from 20 to 40 inches.

Permeability is moderate in the Pheeney soil. Available water capacity is low. Effective rooting depth

is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Vailton soils on mountainsides. Also included are small areas of soils that are more than 40 inches deep to bedrock. Included areas make up about 25 percent of the total acreage.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species on the Pheeney soil. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 135 for Douglas-fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas-fir and 85 for western hemlock. The highest growth rate of an unmanaged, even-aged stand is 138 cubic feet per acre per year at 70 years of age for Douglas-fir and 182 cubic feet per acre per year at 50 years of age for western hemlock. Areas of ridgetops that are subject to strong, persistent winds are less productive than other areas of this unit.

The main limitation affecting the harvesting of timber is slope. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available. The Rock outcrop hinders yarding and may cause breakage of timber when trees are felled. Avoiding large areas of Rock outcrop results in the convergence of yarding paths and skid trails and thus in compaction of the soil. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and seedling mortality are the main concerns in the production of timber on the Pheeney soil. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Droughtiness in the surface layer reduces the seedling survival rate. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock. The Rock outcrop limits the even distribution of reforestation. Because the rooting depth is restricted by the bedrock underlying the Pheeney soil, trees are subject to occasional windthrow.

Common forest understory plants are western brackenfern, vine maple, cascade Oregongrape, western swordfern, and red huckleberry. This map unit is in capability subclass VIIe.

97-Salkum silty clay loam, 3 to 8 percent slopes. This deep, well drained soil is on terraces. It formed in residuum derived dominantly from highly weathered, ancient glacial drift. The native vegetation is mainly conifers. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 12 inches thick. The upper 27 inches of the subsoil is reddish brown silty clay, the next 12 inches is yellowish red silty clay, and the lower part to a depth of 60 inches or more is yellowish red silty clay.

Included in this unit are small areas of Galvin soils on alluvial fans, Prather soils on broad ridgetops, and Scamman soils on terraces. Also included are small areas of Salkum silty clay loam that have slopes of 8 to 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Salkum soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for hayland, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western hemlock, grand fir, bigleaf maple, western redcedar, and bitter cherry. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 164. On the basis of a 50-year site curve, it is 126. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 174 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the

stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, cascade Oregongrape, vine maple, red huckleberry, western swordfern, and western brackenfern.

This unit is well suited to hay and pasture. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This unit is suited to homesites. The main limitation affecting septic tank absorption fields is the slow permeability. This limitation can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIe,

98-Salkum silty clay loam, 8 to 15 percent slopes. This deep, well drained soil is on upland terraces. It formed in residuum derived dominantly from highly weathered, ancient glacial drift. The native vegetation is mainly conifers. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 65 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 12 inches thick. The upper 27 inches of the subsoil is reddish brown silty clay, the next 12 inches is yellowish red silty clay, and the lower part to a depth of 60 inches or more is yellowish red silty clay.

Included in this unit are small areas of Centralia, Melbourne, Prather, and Scamman soils on terraces. Also included are small areas of Salkum silty clay loam that have slopes of 3 to 8 percent and 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Salkum soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for hayland, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, western hemlock, grand fir, bigleaf maple, western redcedar, and bitter cherry. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 164. On the basis of a 50-year site curve, it is 126. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 174 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, cascade Oregongrape, vine maple, red huckleberry, western swordfern, and western brackenfern.

This unit is well suited to hay and pasture. The main hazard is water erosion. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. This method permits the even, controlled application of water and helps to control runoff and erosion.

The main limitation affecting homesites is the slope. Preserving the existing plant cover during construction helps to control erosion.

The main limitation affecting septic tank absorption fields is the slow permeability. This limitation can be overcome by increasing the size of the absorption field. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

99-Salkum silty clay loam, 15 to 30 percent slopes. This deep, well drained soil is on terraces. It formed in residuum derived dominantly from highly weathered, ancient glacial drift. The native vegetation is mainly conifers. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 12 inches thick. The upper 27 inches of the subsoil is reddish brown silty clay, the next 12 inches is yellowish red silty clay, and the lower part to a depth of 60 inches or more is yellowish red silty clay.

Included in this unit are small areas of Centralia and Melbourne soils on terraces. Also included are small areas of Salkum silty clay loam that have slopes of 8 to 15 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Salkum soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, grand fir, bigleaf maple, western redcedar, and bitter cherry. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 164. On the basis of a 50-year site curve, it is 126. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 174 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are salal, cascade Oregongrape, vine maple, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

100-Scamman silty clay loam, 0 to 5 percent slopes. This deep, somewhat poorly drained soil is on terraces. It formed in mixed glaciofluvial and sedimentary material. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 1,600 feet. The average annual precipitation is 45 to 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 5 inches thick. The subsurface layer is dark yellowish brown, mottled silty clay loam about 6 inches thick. The next 13 inches is a mixture of dark brown. mottled silty clay loam and gray silt loam. The subsoil to a depth of 60 inches or more is dark grayish brown, mottled silty clay.

Included in this unit are small areas of Baumgard, Melbourne, Pheeney, Prather, and Salkum soils on uplands, Centralia soils on terraces, Mashel soils on glaciated plains, and Rainier soils on mountainsides. Also included are small areas of Scamman silty clay loam that have slopes of 5 to 20 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the Scamman soil and slow in the subsoil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table is at a depth of about 6 to 18 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for hay and pasture.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are western hemlock, red alder, grand fir, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 152. On the basis of a 50-year site curve, it is 116. The highest average growth

rate of an unmanaged, even-aged stand of Douglas-fir is 161 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table inhibits root respiration and thus results in a lower seedling survival rate. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

Common forest understory plants are western swordfern, cascade Oregongrape, salal, salmonberry, and vine maple.

The main limitation affecting hay and pasture is the seasonal high water table. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

This map unit is in capability subclass IIIw.

101-Scamman silty clay loam, 5 to 20 percent slopes. This deep, somewhat poorly drained soil is on terraces. It formed in mixed glaciofluvial and sedimentary material. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 1,600 feet. The average annual precipitation is 45 to 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silty clay loam about 5 inches thick. The subsurface layer is dark yellowish brown, mottled silty clay loam about 6 inches thick. The next 13 inches is a mixture of dark brown, mottled silty clay loam and gray silt loam. The subsoil to a depth of 60 inches or more is dark grayish brown, mottled silty clay.

Included in this unit are small areas of Baumgard, Melbourne, Pheeney, Prather, and Salkum soils on uplands, Centralia soils on terraces, Mashel soils on glaciated plains, and Rainier soils on mountainsides. Also included are small areas of Scamman silty clay loam that have slopes of 0 to 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Scamman soil and slow in the subsoil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table is at a depth of about 6 to 18 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 152. On the basis of a 50-year site curve, it is 116. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 161 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and sticky and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table inhibits root respiration and thus results in a lower seedling survival rate. When openings are

made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

Common forest understory plants are western swordfern, cascade Oregongrape, salal, salmonberry, and vine maple.

This map unit is in capability subclass IIIe.

102-Schneider very gravelly loam, 20 to 40 percent slopes. This deep, well drained soil is on foothills and mountains. It formed in colluvium derived from basalt. The native vegetation is mainly conifers. Elevation is 500 to 1,200 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown very gravelly loam about 6 inches thick. The upper 26 inches of the subsoil is dark reddish brown very gravelly silt loam, and the lower 23 inches is dark brown extremely gravelly silt loam. Basalt is at a depth of about 55 inches. Depth to the basalt ranges from 40 to 60 inches.

Included in this unit are small areas of Delphi soils on glacial till plains, Grove soils on outwash terraces, Olympic soils on uplands, and Raught soils on shoulder slopes. Also included are small areas of Schneider very gravelly loam that have slopes of 40 to 60 percent and small areas of soils that are less than 40 inches deep to bedrock. Included areas make up about 15 percent of the total acreage.

Permeability and available water capacity are moderate in the Schneider soil. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 151. On the basis of a 50-year site curve, it is 113. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 159 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a' plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are vine maple, salmonberry, cascade Oregongrape, salal, and western swordfern.

This map unit is in capability subclass IVe.

103-Schneider very gravelly loam, 40 to 65 percent slopes. This deep. well drained soil is on foothills and mountains. It formed in colluvium derived from basalt. The native vegetation is mainly conifers. Elevation is 500 to 1,200 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown very gravelly loam about 6 inches thick. The upper 26 inches of the subsoil is dark reddish brown very gravelly silt loam, and the lower 23 inches is dark brown extremely gravelly silt loam. Basalt is at a depth of about 55 inches. Depth to the basalt ranges from 40 to 60 inches.

Included in this unit are small areas of Delphi soils on glacial till plains, Grove soils on outwash terraces, Olympic soils on uplands, and Raught soils on shoulder slopes. Also included are small areas of Schneider very gravelly loam that have slopes of 20 to 40 percent and areas of soils that are less than 40 inches deep to bedrock. Included areas make up about 20 percent of the total acreage.

Permeability and available water capacity are moderate in the Schneider soil. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 151. On the

basis of a 50-year site curve, it is 113. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 159 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are vine maple, salmonberry, cascade Oregongrape, salal, and western swordfern.

This map unit is in capability subclass VIIe.

104-Semiahmoo muck. This very deep, very poorly drained soil is on flood plains. Drainage has been altered by subsurface drains and open ditches. The soil formed in herbaceous organic deposits. Slopes are 0 to 1 percent. The native vegetation is mainly sedges and rushes. Elevation is 20 to 300 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the soil is black muck to a depth of 60 inches or more.

Included in this unit are small areas of Semiahmoo soils that have not been artificially drained and small areas of Shalcar Variant, Puget, and Sultan soils in depressions on flood plains. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Semiahmoo soil. Available water capacity is high. Effective rooting depth is limited by a controlled water table. Runoff is slow, and water erosion is not a hazard. This soil is subject to rare flooding (fig. 2).

This unit is used for cropland, hayland, or pasture. Sweet corn and small grain are commonly grown. Most of the crops commonly produced in the survey area can be grown if an adequate drainage system is installed. The main limitation affecting cropland is the high water table. During the growing season, the water table should be lowered to a depth of about 2 to 5 feet. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface during the nongrowing season.

All forage crops commonly produced in the survey area can be grown if the drainage system is adequate. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface during the nongrowing season. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year.

This unit has limited potential for woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 85. The highest average growth rate for red alder is about 90 cubic feet per acre per year at age 40 provided a fully stocked stand is established.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Logging roads generally are not located on this unit. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods.

Seedling mortality and seedling establishment are the main concerns in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. The seasonal high water table inhibits root respiration and thus results in a lower seedling survival rate. Because the rooting depth is restricted by the seasonal high water table. trees are frequently subject to windthrow.

This map unit is in capability subclass IIw.

Figure 2.-Flooding in an area of Semiahmoo muck. Spanaway gravelly sandy loam, 0 to 3 percent slopes, is on the low terraces, and Olympic and Raught soils are in the background.

105-Shalcar muck. This deep, very poorly drained soil is in upland depressions. It formed in herbaceous organic deposits over alluvium. Slopes are 0 to 2 percent. The native vegetation is mainly sedges and rushes. Elevation is 50 to 700 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black muck about 24 inches thick. The upper 5 inches of the substratum is olive gray silt loam, and the lower part to a depth of 60 inches or more is grayish brown, mottled silty clay loam.

Included in this unit are small areas of Dupont, Everson, McKenna, Mukilteo, and Norma soils in depressions. Also included are small areas of Shalcar soils that have been artificially drained. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Shalcar soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface from October to April. Runoff is ponded, and water erosion is not a hazard.

This unit is used mainly for wildlife habitat. Where drained, it is also used for hayland, pasture, or blueberries.

The main limitations affecting hay and pasture are the seasonal high water table and the ponding. Some areas have been partially drained, but adequate drainage systems have not been maintained. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available.

This unit has limited potential for woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 85. The highest average growth rate for red alder is about 90 cubic feet per acre per year at age 40 provided a fully stocked stand is established.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Logging roads generally are not located on this unit. Rock for road construction is not readily available. The seasonal high water table and the ponding limit the use of equipment to dry periods.

Seedling mortality and seedling establishment are the main concerns in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. The seasonal high water table inhibits root respiration and thus results in a lower seedling survival rate. Because the rooting depth is restricted by the seasonal high water table, trees are frequently subject to windthrow.

This map unit is in capability subclass Vlw.

106-Shalcar Variant muck. This deep, very poorly drained soil is on flood plains. It formed in herbaceous organic deposits over alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly sedges and rushes. Elevation is 20 to 300 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown muck about 6 inches thick. The next 14 inches is black muck. The upper 5 inches of the substratum is very dark grayish brown and grayish brown silty clay, and the lower part to a depth of 60 inches or more is very dark grayish brown and dark brown clay.

Included in this unit are small areas of Puget, Semiahmoo, and Sultan soils on flood plains. Also included are small areas of Shalcar Variant soils that have been artificially drained. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the organic part of the Shalcar Variant soil and slow in the substratum. Available water capacity is high. Effective rooting depth is 20 to 40 inches. A seasonal high water table is at or above the surface from October to May. Runoff is slow, and water erosion is not a hazard. This soil is occasionally flooded for long periods from November to May.

This unit is used mainly for hay and pasture. The main limitations affecting hay and pasture are the seasonal high water and the ponding. Some areas have been partially drained, but adequate drainage systems have not been maintained. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available.

This map unit is in capability subclass Vw.

107-Skipopa silt loam, 0 to 3 percent slopes. This moderately deep, somewhat poorly drained soil is on terraces. It formed in volcanic ash and loess over glaciolacustrine sediment. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 300 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The upper 7 inches of the subsoil is brown silt loam, and the lower 3 inches is grayish brown, mottled silty clay loam. The substratum to a depth of 60 inches or more is greenish gray, mottled silty clay and clay.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains, Bellingham and

Mukilteo soils in depressions, and Everett, Giles, and Yelm soils on terraces. Also included are small areas of Skipopa silt loam that have slopes of 3 to 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the subsoil of the Skipopa soil and very slow in the substratum. Available water capacity is moderate. Effective rooting depth is 15 to 30 inches. A perched seasonal high water table fluctuates between depths of 12 and 24 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland, hayland, pasture, or cropland. It is also used for homesites.

Douglas-fir and red alder are the main woodland species on this unit. Among the trees of limited extent are western redcedar and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 151 for Douglas-fir. On the basis of a 50-year site curve, it is 116 for Douglas-fir and 97 for red alder. The highest average growth rate for an unmanaged, even-aged stand is 159 cubic feet per acre per year at 60 years of age for Douglas-fir and 113 cubic feet per acre per year at 40 years of age for red alder.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

Common forest understory plants are western swordfern, salmonberry, western brackenfern, trailing blackberry, and red huckleberry.

The main limitation affecting hay and pasture is the seasonal high water table. All forage crops commonly produced in the survey area can be grown if the drainage system is adequate. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Wheat and oats are commonly grown on this soil. The main limitations affecting cropland are the seasonal high water table and the very slow permeability. Artificial drainage improves the timeliness of fieldwork and increases yields of perennial crops. Drainage tile should be closely spaced because of the very slow permeability. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. Because of the very slow permeability, the application should be regulated so that water does not stand on the surface and damage the crops.

The main limitation affecting homesites is the seasonal wetness. A drainage system is needed if roads or buildings are constructed on this soil. A drainage system also is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. The main limitations affecting septic tank absorption fields are the seasonal wetness and the very slow permeability, which increase the likelihood that the disposal system will fail, especially during rainy periods.

This map unit is in capability subclass IIIw.

108-Skipopa silt loam, 3 to 15 percent slopes. This moderately deep, somewhat poorly drained soil is on terraces. It formed in volcanic ash and loess over glaciolacustrine sediment. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 300 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The upper 7 inches of the subsoil is dark brown silt loam, and the lower 3 inches is

grayish brown, mottled silt loam. The substratum to a depth of 60 inches or more is greenish gray, mottled silty clay and clay.

Included in this unit are small areas of Alderwood and Kapowsin soils on till plains and Everett, Giles, and Yelm soils on terraces. Also included are small areas of Skipopa silt loam that have slopes of 0 to 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the subsoil of the Skipopa soil and very slow in the substratum. Available water capacity is moderate. Effective rooting depth is 15 to 30 inches. A perched seasonal high water table fluctuates between depths of 12 and 24 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland, hayland, or pasture. It is also used for homesites.

Douglas-fir and red alder are the main woodland species on this unit. Among the trees of limited extent are western redcedar and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 151 for Douglas-fir. On the basis of a 50-year site curve, it is 116 for Douglas-fir and 97 for red alder. The highest average growth rate of an unmanaged, even-aged stand is 159 cubic feet per acre per year at 60 years of age for Douglas-fir and 113 cubic feet per acre per year at 40 years of age for red alder.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts, soil compaction, and damage to tree roots. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to occasional windthrow.

Common forest understory plants are western swordfern, salmonberry, western brackenfern, trailing blackberry, and red huckleberry.

This unit is suited to hay and pasture. The main limitations affecting hay and pasture are the seasonal high water table and water erosion. Grasses and legumes grow well if fertilizer is applied. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. The seedbed should be prepared on the contour or across the slope where practical. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

The main limitation affecting homesites is the seasonal wetness. A drainage system is needed if roads or buildings are constructed on this soil. A drainage system also is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Topsoil can be stockpiled and used to reclaim areas disturbed during construction.

The main limitations affecting septic tank absorption fields are the seasonal wetness and the very slow permeability, which increase the likelihood that the disposal system will fail, especially during rainy periods. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

109-Spana gravelly loam. This very deep, somewhat poorly drained soil is in elongated drainageways on outwash plains. It formed in glacial outwash. Slopes are 0 to 3 percent. The native vegetation is mainly conifers, hardwoods, and grasses. Elevation is 100 to 500 feet. The average annual precipitation is 35 to 45 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black gravelly loam about 22 inches thick. The upper 4 inches of the subsoil is very dark grayish brown gravelly loam, and the lower 12 inches is brown very gravelly loam. The substratum to a depth of 60 inches or more is dark yellowish brown and dark brown extremely gravelly sandy loam.

Included in this unit are small areas of Alderwood soils on glacial till plains and Everett, Indianola, Nisqually, and Spanaway soils on outwash terraces.

Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Spana soil. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. A seasonal high water table is at a depth of about 12 to 36 inches from November to April. Runoff is slow, and the hazard of water erosion is slight.

Most areas are used as hayland and pasture. This unit is suited to hay and pasture. The main limitations are the seasonal high water table and the moderate available water capacity. Proper stocking rates, pasture rotation. and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. In most years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

A few areas are used as woodland. On the basis of a 100-year site curve, the estimated site index for Douglas-fir is 144. On the basis of a 50-year site curve, it is 110. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 150 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. The seasonal high water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, salal, vine maple, western brackenfern, and Oregon white oak.

This map unit is in capability subclass IIIw.

110-Spanaway gravelly sandy loam, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in glacial outwash and volcanic ash. The native vegetation is mainly grasses, ferns, and a few conifers. Elevation is 100 to 400 feet. The average annual precipitation is 45 to 55 inches. the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black gravelly sandy loam about 15 inches thick. The subsoil is dark yellowish brown very gravelly loam about 5 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood soils on till plains; Everett, Indianola, and Nisqually soils on outwash terraces; and Spana soils in depressions. Also included are small areas of Spanaway soils that have a stony sandy loam surface layer and small areas of Spanaway gravelly sandy loam that have slopes of 3 to 15 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Spanaway soil and very rapid in the substratum. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as hayland, pasture, or cropland, as a site for homes, or as a source of gravel. It is also used as woodland.

The main limitation affecting hay and pasture is the low available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is suited to crops. Wheat, oats, strawberries, raspberries, blackberries, and sweet corn are commonly grown. The main limitation is the low available water capacity. In summer, irrigation is needed for maximum production of most crops.

Sprinklers can be used, but a slow application rate is needed to minimize runoff. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. The application rate should be adjusted to the available water capacity, the water intake rate, and the needs of the crop. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year.

This unit is well suited to homesites. Pebbles and cobbles should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants.

The main limitation affecting septic tank absorption fields is a poor filtering capacity. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to sloughing.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are Oregon white oak, lodgepole pine, and red alder. Douglas-fir and Scotch pine are grown on Christmas tree plantations. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 140. On the basis of a 50-year site curve, it is 108. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 145 cubic feet per acre per year at 65 years of age.

This soil is suited to year-round logging. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by Douglas-fir. Oregon white oak, and lodgepole pine occurs periodically in cutover areas. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, salal, western brackenfern, western swordfern, Indian plum, and Scotch-broom.

This map unit is in capability subclass IVs.

111-Spanaway gravelly sandy loam, 3 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in glacial outwash and volcanic ash. The native vegetation is mainly grasses, ferns, and a few conifers. Elevation is 100 to 400 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black gravelly sandy loam about 15 inches thick. The subsoil is dark yellowish brown very gravelly sandy loam about 5 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood soils on till plains and Everett, Indianola, and Nisqually soils on terraces. Also included are small areas of Spanaway soils that have a stony sandy loam surface layer and small areas of Spanaway gravelly sandy loam that have slopes of 0 to 3 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Spanaway soil and very rapid in the substratum. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as hayland or pasture, as a site for homes, or as a source of gravel. It is also used as woodland.

The main limitation affecting hay and pasture is the low available water capacity during the growing season. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is suited to homesites. The main limitation is the slope. Cutbanks are not stable and are subject to sloughing. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. Pebbles and cobbles should be removed, particularly in areas used for lawns. In

summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Topsoil can be stockpiled and used to reclaim areas disturbed during construction.

The main limitation affecting septic tank absorption fields is a poor filtering capacity in the substratum. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are Oregon white oak, lodgepole pine, and red alder. Douglas-fir and Scotch pine are grown on Christmas tree plantations. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 140. On the basis of a 50-year site curve, it is 108. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 145 cubic feet per acre per year at 65 years of age.

This soil is suited to year-round logging. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation of cutover areas by Oregon white oak and lodgepole pine occurs infrequently. Droughtiness in the surface layer reduces the seedling survival rate. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings.

Common forest understory plants are cascade Oregongrape, salal, western brackenfern, western swordfern, Indian plum, and Scotch-broom.

This map unit is in capability subclass IVs.

112-Spanaway stony sandy loam, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in glacial outwash and volcanic ash. The native vegetation is mainly grasses, ferns, and a few conifers. Elevation is 200 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black stony sandy loam about 16 inches thick. The subsoil is very dark brown gravelly sandy loam about 6 inches thick. The substratum to a depth of 60 inches or more is grayish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood soils on till plains, Baldhill soils on terminal moraines, and Everett, Indianola, and Nisqually soils on terraces. Also included are small areas of Spanaway soils that have a gravelly sandy loam surface layer and small areas of Spanaway stony sandy loam that have slopes of 3 to 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Spanaway soil and very rapid in the substratum. Available water capacity is low. 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 hayland, pasture, or homesites. The main limitations affecting hay and pasture are the low available water capacity and the stones on the surface. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Rotation grazing helps to maintain the quality of the forage. Because of the surface stones, spreading animal manure, mowing, and seeding are difficult. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesites. Pebbles, cobbles, and stones should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Cutbanks are not stable and are subject to sloughing.

The main limitation affecting septic tank absorption fields is a poor filtering capacity in the substratum. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVs.

113-Spanaway stony sandy loam, 3 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in glacial outwash and

volcanic ash. The native vegetation is mainly grasses, ferns, and a few conifers. Elevation is 200 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is black stony sandy loam about 16 inches thick. The subsoil is very dark brown gravelly sandy loam about 6 inches thick. The substratum to a depth of 60 inches or more is grayish brown extremely gravelly sand.

Included in this unit are small areas of Alderwood soils on till plains, Everett, Indianola, and Nisqually soils on terraces, and Baldhill soils on terminal moraines. Also included are small areas of Spanaway soils that have a gravelly sandy loam surface layer and small areas of Spanaway stony sandy loam that have slopes of 0 to 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the subsoil of the Spanaway soil and very rapid in the substratum. Available water capacity is low. 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 hayland, pasture, or homesites. The main limitations affecting hay and pasture are the low available water capacity and the stones on the surface. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Rotation grazing helps to maintain the quality of the forage. Because of the surface stones, spreading animal manure, mowing, and seeding are difficult. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesites. The main limitation is the slope. Cutbanks are not stable and are subject to sloughing. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. Pebbles, cobbles, and stones should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Topsoil can be stockpiled and used to reclaim areas disturbed during construction.

The main limitation affecting septic tank absorption fields is a poor filtering capacity in the substratum. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVs.

114-Spanaway-Nisqually complex, 2 to 10 percent slopes. This map unit is on mounds and in areas between mounds. The mounds are circular or elliptical, and they are 3 to 5 feet high in the center (fig. 3). The native vegetation is mainly grasses and ferns. Elevation is 100 to 250 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 150 to 200 days.

This unit is 60 percent Spanaway gravelly sandy loam, which has a slope of 2 to 5 percent, and 30 percent Nisqually loamy fine sand, which has a slope of 2 to 10 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

The Spanaway soil is very deep and somewhat excessively drained. It formed in gravelly glacial outwash and volcanic ash. Typically, the surface layer is black gravelly sandy loam about 15 inches thick. The subsoil is dark yellowish brown very gravelly sandy loam about 5 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Permeability is moderately rapid in the subsoil of the Spanaway soil and very rapid in the substratum. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Nisqually soil is deep and somewhat excessively drained. It formed in sandy glacial outwash. Typically, the upper part of the surface layer is black and very dark gray loamy fine sand about 18 inches thick, and the lower part is very dark grayish brown loamy fine sand about 13 inches thick. The substratum to a depth of 60 inches or more is light olive brown loamy sand.

Permeability is moderately rapid in the surface layer of the Nisqually soil and very rapid in the substratum. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Included in this unit are small areas of Everett and Indianola soils on terraces. Included areas make up about 10 percent of the total acreage.

This unit is used for hayland, pasture, or homesites. In the areas used for hay and pasture, the main

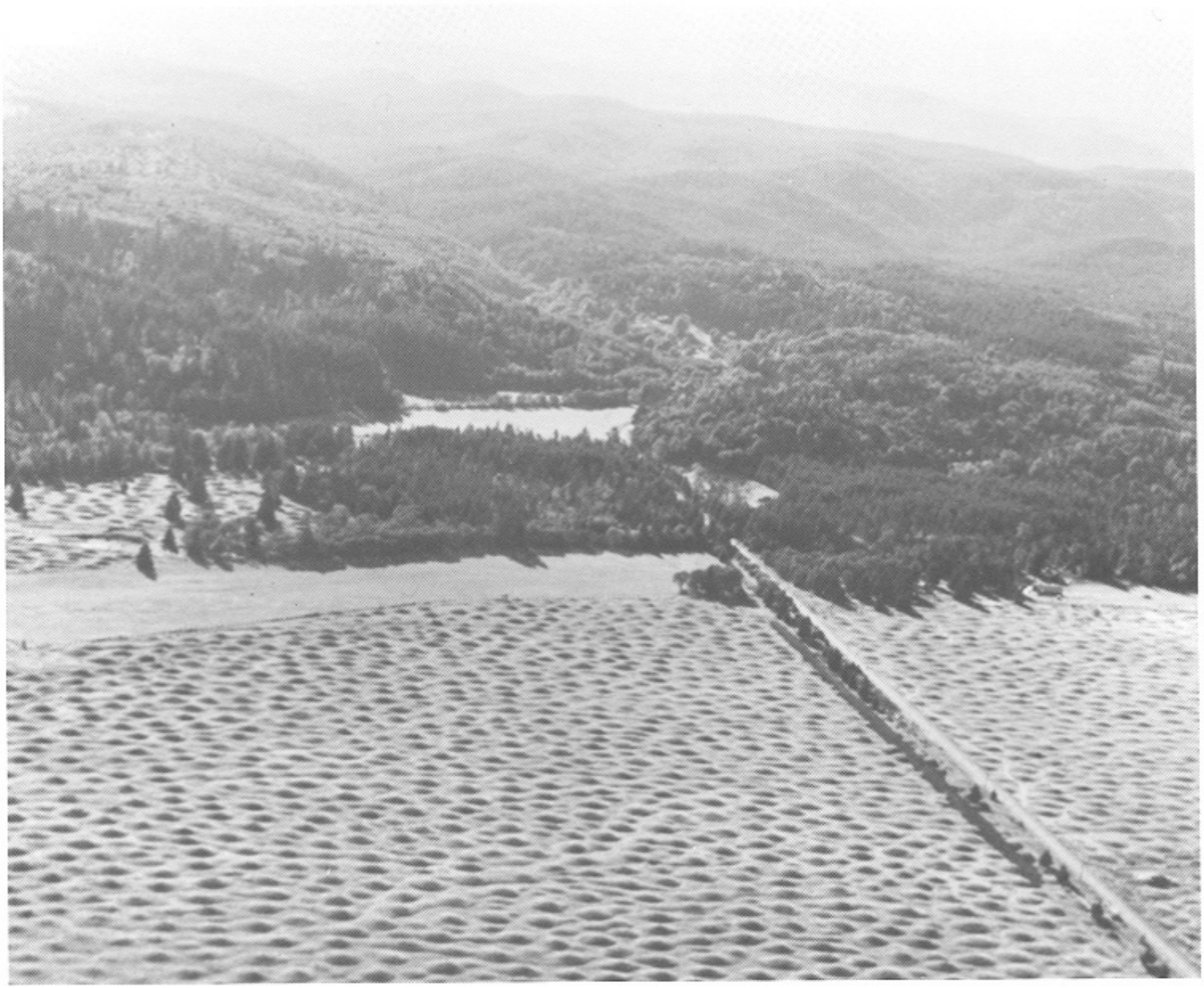

Figure 3.-An area of Spanaway-Nisqually complex, 2 to 10 percent slopes, in the foreground. Olympic and Raught soils are in the background. (Photo by Washington State Department of Natural Resources)

limitation is the low available water capacity. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. Rotation grazing helps to maintain the quality of the forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In summer, irrigation is needed for maximum production of most forage crops. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesites. Pebbles and cobbles should be removed, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental

trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Cutbanks are not stable and are subject to sloughing.

The main limitation affecting septic tank absorption fields is a poor filtering capacity in the substratum. If the density of housing is moderate or high, community sewage systems are needed to prevent the contamination of water supplies caused by seepage from onsite sewage disposal systems. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVs.

115-Sultan silt loam. This very deep, moderately well drained soil is on flood plains. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 20 to 75 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark yellowish brown silt loam about 7 inches thick. The upper 8 inches of the subsoil is dark yellowish brown silt loam, the next 10 inches is dark brown, mottled silt loam, and the lower 20 inches is dark yellowish brown, mottled silt loam. The substratum to a depth of 60 inches or more is grayish brown, mottled silt loam.

Included in this unit are small areas of Godfrey and Puget soils in depressions and Pilchuck and Puyallup soils on terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Sultan soil. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of about 24 to 48 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. This soil is occasionally flooded for brief periods from November to April.

This unit is used for hayland, pasture, or cropland. It is well suited to hay and pasture. The main limitations affecting hay and pasture are the seasonal high water table and the flooding. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

Corn silage, sweet corn, rhubarb, and small grain are commonly grown on this soil. The main limitations affecting cropland are the seasonal high water table and the flooding. The flooding can be controlled by dikes and levees. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. A cover crop should be planted in the fall to protect the soil from erosion during periods of flooding. In some years irrigation is needed for maximum production.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 160. On the basis of a 50-year site curve, it is 120. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 170 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. The flooding limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. The flooding inhibits root respiration and thus results in some seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This map unit is in capability subclass IIw.

116-Tacoma silt loam. This deep, very poorly drained soil is on flood plains and deltas. It formed in alluvium high in content of volcanic ash. Slopes are 0 to 1 percent. The native vegetation is mainly sedges, grasses, and willows. Elevation is 0 to 20 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown, mottled silt loam about 7 inches thick. The upper 33 inches of the subsoil is dark grayish brown, mottled silt loam, and the

lower 10 inches is grayish brown, mottled silt loam. The substratum to a depth of 60 inches or more is dark greenish gray, mottled clay.

Included in this unit are small areas of Hydraquents, tidal, and Puget soils on flood plains. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Tacoma soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface from November to June. Runoff is ponded, and water erosion is not a hazard. This soil is frequently flooded for brief periods from November to June.

This unit is used for hay and pasture. The main limitations affecting hay and pasture are the seasonal high water table and the flooding. All of the forage crops commonly produced in the survey area can be grown if the drainage system is adequate. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Rotation grazing helps to maintain the quality of forage.

This map unit is in capability subclass Vw.

117-Tenino gravelly loam, 3 to 15 percent slopes. This moderately deep, well drained soil is on terminal moraines. It formed in glacial till over glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 400 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown and dark yellowish brown gravelly loam about 11 inches thick. The upper 10 inches of the subsoil is dark brown gravelly loam, the next 15 inches is dark yellowish brown gravelly loam, and the lower 4 inches is a weakly cemented, strongly compacted, yellowish brown hardpan. The hardpan crushes to very gravelly loam. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly sandy loam. Depth to the hardpan ranges from 25 to 40 inches.

Included in this unit are small areas of Alderwood soils on till plains and Everett and Indianola soils on terraces. Also included are small areas of Tenino gravelly loam that have slopes of 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate above the hardpan in the Tenino soil, very slow in the pan, and very rapid below the pan. Available water capacity is moderate. Effective rooting depth is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for woodland. It is also used for hayland, pasture, or homesites.

Douglas-fir is the main woodland species on this unit. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 154. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 163 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality and seedling establishment are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are salal, cascade Oregongrape, western brackenfern, western swordfern, and trailing blackberry.

The main limitations affecting hay and pasture are the moderate available water capacity and the restricted soil depth. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The seedbed should be prepared on the contour or across the slope where practical. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure

can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. This method permits the even, controlled application of water, reduces the runoff rate, and minimizes the risk of erosion.

The main limitations affecting homesites are the depth to the hardpan and the slope. The cuts needed to provide essentially level building sites can expose the hardpan. The hardpan is rippable. Excavating for roads and buildings increases the hazard of erosion, especially in the steeper areas. This hazard can be reduced by preserving the existing plant cover during construction. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. Only the part of the site that is used for construction should be disturbed. The hazard of erosion is increased if the surface is bare during site development. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small-seeded plants. Cutbanks are not stable and are subject to sloughing.

The main limitation affecting septic tank absorption fields is the weakly cemented hardpan. The suitability of the soil for these fields can be improved by ripping the very slowly permeable hardpan. Because of the restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of heavy rainfall. Absorption lines should be installed below the very slowly permeable layer. Increasing the size of the absorption area helps to compensate for the restricted permeability. The slope hinders the installation of the absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclass IVe.

118-Tenino gravelly loam, 15 to 30 percent slopes. This moderately deep, well drained soil is on terminal moraines. It formed in glacial till over glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 400 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown and dark yellowish brown gravelly loam about 11 inches thick. The upper 10 inches of the subsoil is dark brown gravelly loam, the next 15 inches is dark yellowish brown gravelly loam, and the lower 4 inches is a weakly cemented, strongly compacted, yellowish brown hardpan. The hardpan crushes to very gravelly loam. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly sandy loam. Depth to the hardpan ranges from 25 to 40 inches.

Included in this unit are small areas of Alderwood soils on till plains and Everett and Indianola soils on terraces. Also included are small areas of Tenino gravelly loam that have slopes of 3 to 15 percent or 30 to 60 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate above the hardpan in the Tenino soil, very slow in the pan, and very rapid below the pan. Available water capacity is moderate. Effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as a woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 154. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 163 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling mortality and seedling establishment are the .main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are salal, cascade Oregongrape, western brackenfern, western swordfern, and trailing blackberry.

This map unit is in capability subclass IVe.

119-Tenino gravelly loam, 30 to 60 percent slopes. This moderately deep, well drained soil is on terminal moraines. It formed in glacial till over glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 400 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the surface layer is dark reddish brown and dark yellowish brown gravelly loam about 11 inches thick. The upper 10 inches of the subsoil is dark brown gravelly loam. the next 15 inches is dark yellowish brown gravelly loam, and the lower 4 inches is a weakly cemented. strongly compacted, yellowish brown hardpan. The hardpan crushes to very gravelly loam. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly sandy loam. Depth to the hardpan ranges from 25 to 40 inches.

Included in this unit are small areas of Alderwood and Everett soils on terrace escarpments. Also included are small areas of Tenino gravelly loam that have slopes of 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate above the hardpan in the Tenino soil, very slow in the pan, and very rapid below the pan. Available water capacity is moderate. Effective rooting depth is 25 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 154. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 163 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling mortality and seedling establishment are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings. Because the rooting depth is restricted by the hardpan, trees are subject to occasional windthrow. Droughtiness in the surface layer reduces the seedling survival rate.

Common forest understory plants are salal, cascade Oregongrape, western brackenfern, western swordfern, and trailing blackberry.

This map unit is in capability subclass VIe.

120-Tisch silt loam. This deep, very poorly drained soil is in upland depressions and drainageways. Drainage has been altered by subsurface drains. The soil formed in diatomaceous earth, volcanic ash, and alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly hardwoods, spirea, grasses, and sedges. Elevation is 50 to 200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 150 to 200 days.

Typically, the upper part of the surface layer is very dark brown silt loam about 6 inches thick, and the lower part is very dark grayish brown silt about 5 inches thick. The substratum to a depth of 60 inches or more is stratified black, very dark brown, dark grayish brown, and dark brown silt and muck.

Included in this unit are small areas of Dupont, Everson, McKenna, and Norma soils in depressions and Giles and Yelm soils on terraces. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Tisch soil. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or near the surface from December to April. Runoff is very slow, and erosion is not a hazard. This soil is subject to rare flooding.

This unit is used for hayland, pasture, or cropland. It is suited to hay and pasture. The main limitation is the seasonal high water table. Subsurface drains, open ditches. or both can lower the water table if a suitable outlet is available. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Periodic mowing helps to maintain

uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Rotation grazing helps to maintain the quality of forage.

Corn silage, sweet corn, and small grain are commonly grown on this soil. The main limitation affecting cropland is the seasonal high water table. During the growing season, the water table should be lowered to a depth of about 2 to 5 feet. Most of the crops commonly produced in the survey area can be grown if an adequate drainage system is installed. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and tilth. Irrigation is needed for maximum production in most years. Sprinkler irrigation is the best method of applying water.

In undrained areas this unit is suited to woodland. Red alder is the main woodland species. Western redcedar is of limited extent. On the basis of a 50-year site curve, the mean site index for red alder is 90. The estimated growth rate of red alder is 101 cubic feet per acre per year for an unmanaged, fully stocked stand at 40 years of age.

The main limitation affecting the harvesting of timber is the extreme muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads are generally not built on this unit. Rock for road construction is not readily available. The seasonal high water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. If the stand includes seed trees, natural reforestation by red alder occurs periodically in cutover areas. The seasonal high water table inhibits root respiration and thus results in high seedling mortality. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted western redcedar seedlings. Because the rooting depth is restricted by the seasonal high water table, trees are subject to frequent windthrow.

This unit is in capability subclass IIIw.

121-Vailton silt loam, 5 to 30 percent slopes. This deep, well drained soil is on mountainsides. It formed in colluvium and residuum derived from siltstone and shale mixed with volcanic ash. The native vegetation is mainly conifers and hardwoods. Elevation is 1,700 to 2,500 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

Typically, the upper part of the surface layer is very dark grayish brown silt loam about 10 inches thick, and the lower part is dark brown silty clay loam about 5 inches thick. The upper 15 inches of the subsoil is dark yellowish brown silty clay loam, and the lower 12 inches is dark brown silty clay loam. The substratum is dark yellowish brown silty clay loam about 6 inches thick. Weathered siltstone is at a depth of about 48 inches. Depth to the siltstone ranges from 40 to 60 inches.

Included in this unit are small areas of Baumgard soils on uplands, Jonas and Pheeney soils on mountainsides, and Mal and Wilkeson soils on foothills and mountainsides. Also included are small areas of Vailton silt loam that have slopes of 30 to 65 percent. Included areas make up about 20 percent of the total acreage.

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

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 141 for Douglas-fir and 146 for western hemlock. On the basis of a 50-year site curve, it is 113 for Douglas-fir and 103 for western hemlock. The highest average growth rate for an unmanaged, even-aged stand is 146 cubic feet per acre per year at 65 years of age for Douglas-fir and 230 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the

stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of planted Douglas-fir seedlings and the natural reforestation of western hemlock.

Common forest understory plants are western brackenfern, vine maple, cascade Oregongrape, western swordfern, and salal.

This map unit is in capability subclass IVe.

122-Vailton silt loam, 30 to 65 percent slopes. This deep, well drained soil is on mountainsides. It formed in colluvium and residuum derived from siltstone and shale mixed with volcanic ash. The native vegetation is mainly conifers and hardwoods. Elevation is 1,700 to 2,500 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is 130 to 170 days.

Typically, the upper part of the surface layer is very dark grayish brown silt loam about 10 inches thick, and the lower part is dark brown silty clay loam about 5 inches thick. The upper 15 inches of the subsoil is dark yellowish brown silty clay loam, and the lower 12 inches is dark brown silty clay loam. The substratum is dark yellowish brown silty clay loam about 6 inches thick. Weathered siltstone is at a depth of about 48 inches. Depth to the siltstone ranges from 40 to 60 inches.

Included in this unit are small areas of Baumgard soils on uplands. Jonas and Pheeney soils on mountainsides, and Mal and Wilkeson soils on foothills and mountainsides. Also included are small areas of Vailton silt loam that have slopes of 5 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Vailton soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas-fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve. the mean site index is 141 for Douglas-fir and 146 for western hemlock. On the basis of a 50-year site curve, it is 113 for Douglas-fir and 103 for western hemlock. The highest average growth rate of an unmanaged, even-aged stand is 146 cubic feet per acre per year at 65 years of age for Douglas-fir and 230 cubic feet per acre per year at 50 years of age for western hemlock.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and slippery and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Land slumping and road failure can occur following clearcut harvesting. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by a plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas-fir seedlings and the natural reforestation of western hemlock.

Common forest understory plants are western brackenfern, vine maple, cascade Oregongrape, western swordfern, and salal.

This map unit is in capability subclass VIe.

123-Wilkeson silt loam, 5 to 20 percent slopes. This very deep, well drained soil is on uplands and mountains. It formed in weathered andesite and basalt. The native vegetation is mainly conifers and hardwoods. Elevation is 600 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is 125 to 175 days.

Typically, the surface layer is dark brown silt loam about 11 inches thick. The upper 12 inches of the subsoil is dark yellowish brown silty clay loam, the next 24 inches is dark brown gravelly silty clay loam, and the lower part to a depth of 60 inches or more is dark brown gravelly clay loam.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Pheeney soils on mountainsides. Also included are small areas of Wilkeson silt loam that have slopes of 20 to 40 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Wilkeson soil.

Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, western redcedar, and bitter cherry. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

Common forest understory plants are vine maple, western swordfern, red huckleberry, salal, and trailing blackberry.

This map unit is in capability subclass IIIe.

124-Wilkeson silt loam, 20 to 40 percent slopes. This very deep, well drained soil is on uplands and mountains. It formed in weathered andesite and basalt. The native vegetation is mainly conifers and hardwoods. Elevation is 600 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is 125 to 175 days.

Typically, the surface layer is dark brown silt loam about 11 inches thick. The upper 12 inches of the subsoil is dark yellowish brown gravelly silty clay loam, the next 24 inches is dark brown gravelly silty clay loam, and the lower part to a depth of 60 inches or more is dark brown gravelly clay loam.

Included in this unit are small areas of Baumgard soils on uplands and Jonas and Pheeney soils on mountainsides. Also included are small areas of Wilkeson silt loam that have slopes of 5 to 20 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Wilkeson soil. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas-fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, western redcedar, and bitter cherry. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate of an unmanaged, even-aged stand of Douglas-fir is 171 cubic feet per acre per year at 65 years of age.

The main limitation affecting the harvesting of timber is slope. The slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and minimize damage to the surface. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Rock outcrop hinders yarding and may cause breakage of timber when the trees are felled. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by a plant cover or adequate water bars are provided. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by western hemlock and red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory plants are vine maple, western swordfern, red huckleberry, salal, and trailing blackberry.

This map unit is in capability subclass VIe.

125-Xerorthents, 0 to 5 percent slopes. These deep, moderately well drained to somewhat excessively drained soils are on uplands and tidelands. They formed in sandy and loamy cut and fill material. The

native vegetation is Scotch-broom and various weeds and grasses. Elevation is 0 to 800 feet. The average annual precipitation is 40 to 60 inches. the average annual air temperature is about 50 degrees F. and the average frost-free period is 150 to 200 days.

The surface soil and subsoil have been removed or covered with other soil material. Texture and depth vary greatly within short distances.

Included in this unit are small areas of Alderwood and Everett soils on till plains and areas filled with nonsoil material. Included areas make up about 20 percent of the total acreage.

Permeability, available water capacity, and effective rooting depth vary in the Xerorthents. Runoff is slow, and the hazard of water erosion is slight. These soils are subject to rare flooding.

This unit is used for industrial sites. The main management concern is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be built above the expected flood level.

This map unit is in capability subclass VIIs.

126-Yelm fine sandy loam, 0 to 3 percent slopes. This deep, moderately well drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 25 to 300 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface layer is dark brown fine sandy loam about 8 inches thick. The upper 9 inches of the subsoil is dark yellowish brown fine sandy loam, and the lower 29 inches is dark grayish brown and olive brown, mottled fine sandy loam. The substratum to a depth of 60 inches or more is light olive brown loamy sand.

Included in this unit are small areas of Everson and Norma soils in depressions and Cagey, Giles. Indianola, and Skipopa soils on terraces. Also included are small areas of Yelm fine sandy loam that have slopes of 3 to 15 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid in the Yelm soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table fluctuates between depths of 18 and 36 inches from December to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for cropland, hayland, pasture, or specialty crops. It is also used for woodland or homesites.

Corn silage, sweet corn, raspberries, strawberries, and small grain are commonly grown on this soil. The main limitation affecting cropland is the seasonal high water table. Artificial drainage improves the timeliness of fieldwork and increases yields of perennial crops. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available. Applying animal manure and returning crop residue to the soil help to maintain the organic matter content, fertility, and filth. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water.

The main limitation affecting hay and pasture is the seasonal high water table. Grasses and legumes grow well if fertilizer is applied. Grazing when the soil is wet damages the plants and results in compaction of the surface layer. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. Subsurface drains, open drains, or both can lower the water table if a suitable outlet is available. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged, even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings

are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

The main limitation affecting homesites and septic tank absorption fields is the seasonal wetness. A drainage system is needed. Cutbanks are not stable and are subject to sloughing.

This map unit is in capability subclass IIw.

127-Yelm fine sandy loam, 3 to 15 percent slopes. This deep, moderately well drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 25 to 300 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface layer is dark brown fine sandy loam about 8 inches thick. The upper 9 inches of the subsoil is dark yellowish brown fine sandy loam, and the lower 29 inches is dark grayish brown and olive brown., mottled fine sandy loam. The substratum to a depth of 60 inches or more is light olive brown loamy sand.

Included in this unit are small areas of Cagey, Giles, Indianola. and Skipopa soils on terraces. Also included are small areas of Yelm fine sandy loam that have slopes of 0 to 3 percent and 15 to 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid in the Yelm soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table fluctuates between depths of 18 and 36 inches from December to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It is also used as woodland or homesites.

The main limitation affecting hay and pasture is the seasonal high water table. Grasses and legumes grow well if fertilizer is applied. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and protect the soil from erosion. The seedbed should be prepared on the contour or across the slope where practical. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and controls weeds. Animal manure can be applied periodically during the growing season. Areas that receive heavy applications should be harrowed at least once a year. In some years irrigation is needed for maximum production. Sprinkler irrigation is the best method of applying water. The amount of water applied should be sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is suited to woodland. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged. even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees, natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

The main limitations affecting homesites are the slope and the seasonal wetness. A drainage system is needed if roads or buildings are constructed. Cutbanks are not stable and are subject to sloughing. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. A plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

The main limitation affecting septic tank absorption fields is the seasonal wetness. The slope hinders the installation of the absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

128-Yelm fine sandy loam, 15 to 30 percent slopes. This deep, moderately well drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and hardwoods. Elevation is 25 to 300 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 51 degrees F, and the average frost-free period is 170 to 200 days.

Typically, the surface layer is dark brown fine sandy loam about 8 inches thick. The upper 9 inches of the subsoil is dark yellowish brown fine sandy loam, and

the lower 29 inches is dark grayish brown and olive brown, mottled fine sandy loam. The substratum to a depth of 60 inches or more is light olive brown loamy sand,

Included in this unit are small areas of Giles, Hoogdal and Indianola soils on terraces. Also included are small areas of Yelm fine sandy loam that have slopes of 3 to 15 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderately rapid in the Yelm soil. Available water capacity is high. Effective rooting depth is 40 to 60 inches. A seasonal high water table fluctuates between depths of 18 and 36 inches from December to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. It is suited to trees. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 173. On the basis of a 50-year site curve, it is 130. The estimated growth rate of an unmanaged. even-aged stand of Douglas-fir is 184 cubic feet per acre per year at 60 years of age.

The main limitation affecting the harvesting of timber is the muddiness caused by seasonal wetness. Use of wheeled and tracked equipment when the soil is wet results in ruts and soil compaction. Unsurfaced roads and skid trails are soft and can be impassable when wet. Logging roads require suitable surfacing material for year-round use. Rock for road construction is not readily available on this unit. Establishing a plant cover on steep slopes that have been cut or filled reduces the hazard of erosion. Disturbance of the protective layer of duff can be minimized by the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If the stand includes seed trees.. natural reforestation by red alder occurs readily in cutover areas. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted Douglas-fir seedlings.

This map unit is in capability subclass IVe.

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 meeting 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 inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food and fiber or are available for these uses. Urban or built-up land, public land. and water areas cannot be considered prime farmland. Urban or built-up land is any contiguous unit of land 10 acres or more in size that is used for such purposes as housing, industrial, and commercial sites, sites for institutions or public buildings, small parks, golf courses, cemeteries, railroad yards, airports, sanitary landfills, sewage treatment plants, and water control structures. Public land is land not available for farming in national forests, national parks, military reservations, and state parks.

Prime farmland soils commonly get an adequate and dependable supply of moisture from precipitation or irrigation. Temperature and length of 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 ranges mainly from 0 to 6 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.

The following map units meet the soil requirements for prime farmland. 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.

14	Bellingham silty clay loam (where drained)
26	Chehalis silt loam
29	Dupont muck (where drained)
31	Eld loam
36	Everson clay loam (where drained)
37	Galvin silt loam, 0 to 5 percent slopes
38	Giles silt loam, 0 to 3 percent slopes
41	Godfrey silty clay loam (where drained)
50	Kapowsin silt loam, 0 to 3 percent slopes
64	Maytown silt loam
69	Mukilteo muck (where drained)
70	Mukilteo muck, drained
71	Newberg fine sandy loam
72	Newberg loam

73	Nisqually loamy fine sand, 0 to 3 percent slopes (where irrigated)
75	Norma fine sandy loam (where drained)
76	Norma silt loam (where drained)
86	Prather silty clay loam, 3 to 8 percent slopes
88	Puget silt loam (where drained)
89	Puyallup silt loam
97	Salkum silty clay loam, 3 to 8 percent slopes
100	Scamman silty clay loam, 0 to 5 percent slopes (where drained)
104	Semiahmoo muck (where drained)
105	Shalcar muck (where drained)
106	Shalcar Variant muck (where drained)
107	Skipopa silt loam, 0 to 3 percent slopes (where drained)
115	Sultan silt loam
120	Tisch silt loam (where drained)
126	Yelm fine sandy loam, 0 to 3 percent slopes

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 natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and 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.

More than 100,000 acres in the county was used for crops and pasture in 1967 (23). Of this total, 6,200 acres was used for row crops, mainly corn for silage; 1,600 acres was used for close-growing crops, mainly wheat and oats; 28,000 acres was used for pasture (fig. 4); and 63,000 acres was used for rotation hay and pasture. The rest was idle cropland. The acreage of crops and pasture has gradually been decreasing as more and more land is used for urban development. In 1967, about 32,000 acres in the county was urban and built-up land.

The paragraphs that follow describe the management needed on the pasture and cropland in the survey area. Management concerns are soil drainage, soil fertility, soil tilth, and water erosion.

Soil drainage is a major management concern on about 50 percent of the acreage used for crops and pasture in the survey area. Some soils are too wet for the crops commonly grown in the area. These include the poorly drained Norma and McKenna soils and the very poorly drained Tisch soils, which make up about 29,000 acres of the survey area, and the organic Mukilteo, Semiahmoo, and Shalcar soils, which make up about 11,800 acres. Unless drained, the poorly drained Bellingham, Everson, Godfrey, and Puget soils are so wet that crops are damaged during most years. These soils make up 13,300 acres of the survey area.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface and subsurface drains is needed in most areas of the poorly drained and very poorly drained soils used

Figure 4.-Irrigated grass pasture in an area of Newberg fine sandy loam.

for crops and pasture. Drains should be more closely spaced in slowly permeable soils than in the more permeable soils. Finding adequate outlets for subsurface drains is difficult in many areas.

Organic soils, such as Semiahmoo and Shalcar, oxidize and subside when their pore space is filled with air. As a result they require special drainage considerations (7). Keeping the water table at the level required by crops during the growing season and then raising it to the surface during other parts of the year minimize the oxidation and subsidence of these soils. Information on the design of drainage systems for each kind of soil is given in the Technical Guide, which is available at the local office of the Soil Conservation Service.

Soil fertility is also a concern in the county. The moderately well drained and well drained soils on uplands and old terraces formed under coniferous forests. Examples are Centralia, Melbourne, Olympic, Prathar, and Salkum soils. These soils are moderately acid and are strongly leached of plant nutrients. The carbon-nitrogen ratio on newly cleared lands is relatively wide, and only small quantities of nitrogen are made available to crops from the soil. Cropping over a period of years tends to increase the organic matter content and narrow the carbon-nitrogen ratio, thus making more nitrogen available for crops (28).

On these soils the main management need is the addition of organic matter and nitrogen, which are best supplied and maintained by planting legumes, rotating

crops, plowing under green-manure crops, and adding barnyard manure. The cost of commercial nitrogen fertilizer may limit its use to the more intensively grown cash crops. Phosphate fertilizer is generally beneficial and can be added with barnyard manure to good advantage.

Cagey, Eld, Galvin, Yelm, and other soils on the younger terraces and alluvial fans have been subject to less weathering and leaching than the soils on uplands and old terraces. They generally are less acid and are higher in inherent fertility. Nevertheless, the nutrient deficiencies and crop responses to soil management are generally similar to those of soils on uplands and old terraces.

Soils on alluvial flood plains are only slightly acid and are high in inherent fertility. Under continuous cropping, however, they are becoming deficient in both nitrogen and phosphorus. Increases in yields have been obtained by applications of fertilizer. The most beneficial results are obtained by applying phosphate and nitrogen fertilizers. Soils in this group include Chehalis, Newberg, Puyallup, and Sultan.

On all soils. additions of lime and fertilizer should be based on the results of soils tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kind and proper amount of fertilizer and lime to be applied.

Soil tilth is an important factor in the germination and emergence of seeds and in the infiltration of water into the soil. Soils that have good tilth are granular and porous.

Most of the soils used for crops have a silty clay loam or silt loam surface layer that is dark in color and moderately high in content of organic matter. Regular additions of crop residue, manure, and other organic material improve soil structure and minimize crusting and the formation of clods.

Generally, well drained and moderately well drained soils can be worked early in spring. These soils are sufficiently drained for early crops in spring and for winter grain. Soils in this group include Prather, Salkum, Giles, and Kapowsin.

The artificially drained Everson and Godfrey soils have a moderately high content of clay in the surface layer. Tilth is a problem because these soils stay wet until late in the spring. If plowed when wet, the soils can become compacted and they tend to be very cloddy when dry. As a result, preparing a good seedbed is difficult. Plowing these soils in the fall generally results in good tilth in the spring.

Water erosion on cropland is a concern if the soil is left bare during the winter rainy season and the slope is more than 2 percent. Growing a winter cover crop between consecutive years of a row crop helps to protect the soil. Other erosion-control practices include tilling across the slope, planting row crops on the contour, applying organic matter, and establishing grassed waterways.

If the vegetative cover is destroyed and the soil is bare during the rainy season, water erosion and sedimentation are problems in areas of industrial and residential development and on other construction sites. Well managed construction projects include plans for control of water and silt during construction and for revegetation and erosion-control structures after the project is completed.

Field crops are grown most intensively on the fertile alluvial flood plains. The principal crops, generally grown for dairy cattle, are corn silage, small grain, hay, and pasture. Well drained soils on the flood plains, such as Chehalis and Puyallup, are naturally fertile and produce high yields. Summer pasture, clover, and grass benefit from irrigation during dry years.

Specialty crops grown for commercial use include blueberries, certified berry plants, raspberries, peas, sweet corn, forest tree seedlings, and Christmas trees. Quaker comfrey is grown in a few areas (fig. 5). It is used for herbal tea. Most specialty crops are grown along the Chehalis and Nisqually Rivers and their tributaries. Christmas trees are grown on the uplands south and east of Olympia. Christmas tree production is gaining steadily in popularity. Douglas-fir, noble fir, grand fir, and Scotch pine are the species most often planted.

The latest information on growing specialty crops 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

Figure 5.-Quaker comfrey in an area of Chehalis silt loam.

and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that ensures the smallest possible loss.

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

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

Crops other than those shown in 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 (20). 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 woodland and for engineering purposes.

In the capability system. soils generally are grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and 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.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland Management and Productivity

Greg Fisher, forester, Soil Conservation Service, Olympia, Washington. prepared this section.

Two-thirds of Thurston County is woodland. Of this acreage, 50 percent is held by private nonindustrial owners and 26 percent by forest industries. The remaining 24 percent is county, state, or federal property.

Thurston County can be divided into four major woodland zones. These zones are shown on the woodland zone map at the back of this publication. They are based on naturally occurring forest overstory species, climate, and soil characteristics. Although the species in the zone name dominate the zone, other species can, and many times do, occur as isolated trees or nearly pure stands. The boundary lines separating the different zones should be thought of as gradual changes in native vegetation and soil rather than a precise division. With few exceptions each woodland zone is made up of distinct kinds of soil. A given soil occurs only in its specific zone. A brief description of each zone follows.

The *Douglas-fir/red alder* zone is the most extensive zone in Thurston County. It includes the Alderwood, Baldhill, Baumgard, Bellingham, Cagey, Cathcart, Centralia, Chehalis, Delphi, Eld, Everett, Everson, Galvin, Giles, Godfrey, Grove, Hoogdal, Indianola, Kapowsin, Mashel, Maytown, McKenna, Melbourne, Newberg, Norma, Olympic, Pilchuck, Prather, Puget, Puyallup, Rainier, Salkum, Scamman, Schneider,

Skipopa, Spana, Sultan, Tacoma, Tenino, Tisch, Wilkeson, and Yelm soils.

Elevation ranges from 0 to 1,700 feet in this zone. The soils are mostly deep and are poorly drained. The temperature is mild, and the frost-free period ranges from 1 25 days. The mean annual precipitation is 35 to 60 inches, however, soil moisture for tree growth is limited during the summer. Associated tree species include western redcedar, bigleaf maple, western hemlock, grand fir, black cottonwood. Pacific madrone, bitter cherry, and western dogwood. Common forest understory species are salal, cascade Oregongrape, western brackenfern, western swordfern, western hazel, vine maple, salmonberry, red huckleberry, trailing blackberry, Pacific trillium, northern twinflower, violet, and bedstraw. Christmas tree production is a common land use on the coarser-textured soils. Douglas-fir, Scotch pine, noble fir, and grand fir are the most common species of Christmas trees.

The main management concerns in this zone are restricted harvesting during the rainy season on the finer textured soils; the invasion of brush and red alder into cutover areas, which can prevent the establishment of planted seedlings; and a high seedling mortality rate on poorly drained and somewhat excessively drained soils. Management practices generally include clear-cut harvesting (fig. 6) when stands reach an age of 50 to 60 years old, removal of logging slash and brush in preparation for reforestation, and hand planting of Douglas-fir seedlings during the first planting season after harvest. Red alder frequently invades cutover areas and, if not controlled, can outcompete young Douglas-fir seedlings. Thinning and fertilizing Douglas-fir stands increase commercial yields at the time of intermediate and final harvest. Young red alder stands are not commonly thinned. Because of their nitrogen-fixing capability, they also are not fertilized.

The *Douglas-fir/Oregon white oak* zone is made up of Nisqually and Spanaway soils. Elevation ranges from 50 to 400 feet. The soils are mostly deep and are somewhat excessively drained. The temperature is mild, and the frost-free period ranges from 150 to 200 days. The mean annual precipitation is 40 to 60 inches; however, soil moisture for tree growth is limited during the summer. Lodgepole pine occurs occasionally as an associated tree species. Common forest understory species include snowberry, salal, western brackenfern, Scotch-broom, cascade Oregongrape, oceanspray, and trailing blackberry. Christmas trees are commonly grown in this zone. Douglas-fir and Scotch pine are the most prevalent species of Christmas trees.

Interspersed within this zone are areas of native prairie. Grasses and ferns are the dominant kinds of prairie vegetation. Clumps of Oregon white oak are common at the margins and on some of the prairies. Douglas-fir has invaded some of the outer limits of the prairies. Scattered limby fir trees are throughout some areas.

The main management concern in this zone is a high seedling mortality rate resulting from a droughty, gravelly surface layer. The soils are well suited to year-round logging. The management for Douglas-fir is similar to that needed in the Douglas-fir/red alder zone. Much of this zone is not used as forest land.

The *Douglas-fir/western hemlock/red alder* zone is made up of Boistfort, Bunder, Jonas, Mal, Pheeney, Raught, and Vailton soils. Elevations ranges from 300 to 2.600 feet. The soils are mostly deep and are well drained. The temperature is mild, and the frost-free period ranges from 120 to 200 days. The mean annual precipitation is 65 to 70 inches. Soil moisture for tree growth is adequate during the summer. Associated tree species include western redcedar, bigleaf maple, grand fir, Sitka spruce, and bitter cherry. Common forest understory species are red huckleberry, salal, western brackenfern, salmonberry, vine maple, devilsclub, and Oregon oxalis.

The *western hemlock/Douglas-fir/Pacific silver fir* zone consists of Katula and Lates soils. It occurs within the Douglas-fir/western hemlock/red alder zone. Elevation ranges from 1,800 to 2,650 feet. The soils are moderately deep. The mean annual precipitation is 70 to 80 inches. The temperature is cool. The frost-free period is shorter than that of the Douglas-fir/western hemlock/red alder zone. Also, red alder is less extensive.

The management concerns and practices in the Douglas-fir/western hemlock/red alder and western hemlock/Douglas-fir/Pacific silver fir zones are similar to those in the Douglas-fir/red alder zone. A major difference, however, is the opportunity of altering harvest methods somewhat to allow for natural reforestation of western hemlock. Western hemlock can tolerate more shade than Douglas-fir. As a result, brush encroachment is less of a problem. Also, in terms of total wood fiber, western hemlock can usually outproduce Douglas-fir in these two zones. As older stands are harvested in the western hemlock/Douglas-fir/Pacific silver fir zone, Pacific silver fir is decreasing in abundance. Noble fir is likely to be a better suited species for reforestation on ridgetops in this higher elevation zone.

The success or failure of many management practices can be predicted through knowledge of the

Figure 6.-A clear-cut area of Douglas-fir on Centralia silt loam, 30 to 60 percent slopes.

properties of the various soils on which trees crow. Detailed descriptions of the various soils are available in the section "Detailed Soil Map Units." The description of each map unit that is suitable for wood crops provides information concerning potential productivity. the limitations that affect timber production and harvesting, and the common tree species and forest understory plants.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The ordination symbol is based on a uniform system of labeling an individual soil to determine the productivity potential and the principal soil properties in

relation to any hazards or limitations of that soil. The first element of the ordination symbol is a number that denotes potential productivity in terms of cubic meters of wood per hectare per year for the indicator tree species. Potential productivity is based on site index and the corresponding culmination of mean annual increment. For example, the number 1 indicates a potential production of 1 cubic meter of wood per hectare per year (14.3 cubic feet per acre per year) and 10 indicates a potential production of 10 cubic meters of wood per hectare per year (143 cubic feet per acre per year). Cubic feet multiplied by 5 gives the approximate growth volume in Scribner board feet.

The second element of the symbol, a letter, indicates the major kind of soil limitation. The letter R indicates steep slopes; X, stoniness or rockiness; W, excess water in or on the soil; T, toxic substances in the soil; D, restricted rooting depth; C, clay in the upper part of the soil; S, sandy texture; and F, a high content of rock fragments in the soil. The letter A indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 7, slight, moderate, and severe indicate the degree of the major soil limitations to be considered in management.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of slight indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of moderate indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of severe indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

As slope gradient and length increase, operating wheeled equipment becomes more difficult. The degree of difficulty generally increases on slopes of 25 to 35 percent. On still steeper slopes, generally of 35 to 45 percent, tracked equipment should be used. On the steepest gradients., even tracked equipment cannot be operated safely, and more sophisticated systems should be used. Wetness, especially in fine textured soils. can severely limit the use of equipment, making harvesting practical only during dry summer months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of slight indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of moderate indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of severe indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of slight indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of moderate indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of severe indicates that many trees can be blown down during these periods.

Plant competition ratings indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are the depth to the water table and the available water capacity. A rating of slight indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of moderate indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of severe indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

The potential productivity of merchantable or common trees on a soil is expressed as a site index and as a productivity class. The site index is the average height,

in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Generally, the higher the site index, the higher the production of wood fiber. A site index for a species on one map unit should be compared only to site indexes for the same species on other map units. A site index was not assigned to any minor species. Because of the lack of data or a suitable site index publication, it also was not assigned to certain principal species (3, *5, 8. 9. 27, 29. 30).*

The *productivity class,* a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic meters per hectare per year, indicates the amount of fiber produced on a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Recreation

The soils of the survey area are rated in table 8 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 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties generally are 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 8 can be supplemented by other information in this survey; for example, interpretations for dwellings without basements and for local roads and streets in table 10 and interpretations for septic tank absorption fields in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains,are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Richard W. Zarvell, soil conservationist, Soil Conservation Service, prepared this section.

Thurston County has a wide variety of habitats for fish and wildlife. These habitats support many interesting and valuable species. They range from saltwater tidelands and shorelines on Puget Sound to the forest plant communities in the Black Hills and the foothills of the Cascade Mountains. Elevation of these areas ranges from 0 to 2,984 feet. Most of the land is privately owned, but there are large parcels of state, federal, and industrial forest property.

Habitat is the arrangement of three essential ingredients-food, cover, and water-required to meet the biological needs of one or more species. Generally, for mammals and birds the critical limiting factor is the availability of their preferred food. Shelter or escape cover is of secondary importance. For salmon and other aquatic species, the most severe limiting factors generally are the sedimentation caused by erosion, the blocking of stream passage by debris, and various forms of water pollution.

Saltwater habitat is an important resource in Thurston County. There are more than 100 miles of saltwater shoreline in the county. Estuaries and tidelands produce oysters, clams, crabs, and many fish species. Numerous kinds of shorebirds and waterfowl, including great blue heron, gulls, sandpipers, mallards, wigeon, goldeneye, and Canada geese, also depend on these habitats.

The Nisqually Delta is particularly important since it is one of the last major unspoiled estuaries along the entire Pacific coast. The Delta area is a highly productive marine nursery of great economic value for both commercial and sport fishing. Nearly 200 species of birds, more than 20 species of mammals, and a rich variety of fish and other aquatic life utilize this environment. This unique area is a living outdoor laboratory, which fosters a host of scientific and educational activities, as well as recreational pursuits.

Most of the county is woodland. The principal conifer species are Douglas-fir and western hemlock. Conifer species of lesser extent are western redcedar and grand fir. The principal deciduous species are red alder and bigleaf maple. Deciduous species of limited extent are black cottonwood. Oregon white oak, bitter cherry, and Pacific madrone. These wooded areas have a diverse understory of salal, cascade Oregongrape, huckleberry, and other species. Wildlife attracted to these areas include raccoon, black-tailed deer, woodpeckers, owls, and songbirds.

Prairie openings and numerous small farms are in areas where the woodland has been cleared. These areas are used mainly for pasture or hay crops, such as reed canarygrass, orchardgrass, fescue, and clover. A small acreage is used for corn or truck crops. These areas support openland wildlife. such as California quail, pheasant, rabbit, and numerous nongame species.

More than 100 freshwater lakes provide habitat for both cold-water and warm-water fish. Warm-water species require a water temperature of more than 65 degrees F and cold-water species one of 65 degrees or less. Warm-water species of game fish in natural waters and manmade reservoirs include bass, bluegill, crappies, perch, and catfish. The principal species of cold-water game fish is rainbow trout.

Many of the rivers and streams that run into Puget Sound once supported large runs of Chinook, coho, and chum salmon and of steelhead trout. These fish require good-quality cold water, clean gravel beds for spawning, pools and riffles for rearing their young, and free access to and from the ocean. Although many runs have been eliminated or severely damaged by poor land use, some streams still produce moderate numbers of these fish. Anadromous fish have high commercial and sport value.

Timber production and farming activities have a great impact on wildlife habitat. Also, expanding urban and recreational developments have destroyed or degraded wildlife habitat. Management of these activities is a determining factor in the future quality of the habitat for fish and wildlife. Few of the soils in the county are managed specifically to provide appropriate wildlife habitat. Consequently, management of the soils used mainly for other purposes largely determines the amount and quality of habitat and the abundance of wildlife.

Proper management of cropland and pasture can enhance wildlife habitat. Suitable practices include planting cover crops; returning crop residue to the soil; leaving strips of undisturbed vegetation along shorelines, streambanks, and fence rows; proper handling of livestock waste to prevent pollution of water; and proper handling of pesticides and chemicals.

Some soils in the area are poorly drained and are suited to the development of ponds, marshes, and wetland areas. Building dikes, water-control structures, and islands and fencing off vital areas can create or improve wetland habitat.

Appropriate woodland management practices can greatly enhance wildlife abundance. Small scale clearcutting creates a diversity of successional stages in

the vegetation and provides food adjacent to cover. Leaving strips of undisturbed vegetation along stream corridors helps to protect spawning gravel and other aquatic habitats from smothering sedimentation; provides shade, which helps to maintain a cold water temperature; and provides food and cover for terrestrial species. Standing snags provide sites for cavity nesting birds and provide food for other animals. The needs of fish and wildlife should be considered when logging roads and skid trails are constructed. Seeding burns, roads, skid trails, and other disturbed areas to grasses and legumes helps to stabilize soils, provides food, and reduces water pollution. Logging practices that help to keep debris from blocking streams and reduce the risk of erosion should be used.

As both urban and rural populations increase, careful planning is needed to preserve as much wildlife habitat as possible. Landscaping can both beautify urban areas and provide habitat. Control of sediment from construction sites is needed to prevent disturbance to adjacent areas and water pollution. Proper disposal systems for sewage, storm runoff, pesticides, and other possibly harmful pollutants are also needed. Strips of riparian vegetation should be maintained to reduce the risk of streambank erosion, intercept sediment, and provide food and cover.

The successful management of wildlife in any area requires that food, cover, and water be available in a suitable combination. Lack of any one element, or an imbalance of any one, will keep the desired species from inhabiting the area.

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.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair. poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

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

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are western brackenfern and western swordfern.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are red alder, willow, vine maple, and dogwood.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness.

Examples of coniferous plants are Douglas-fir, western redcedar, and western hemlock.

Shrubs are bushy woody plants that produce fruit, buds. twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone. available water capacity, salinity, and soil moisture. Examples of shrubs are salmonberry, salal, cascade Oregongrape, huckleberry, snowberry, and elderberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, saltgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl-feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include California quail, pheasant, meadowlark, robin, field sparrow, crow, killdeer, and rabbit.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants, or both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include band-tailed pigeons, ruffed grouse, mountain beavers, woodpeckers, squirrels, raccoon, black-tailed deer, and black bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, kingfishers, muskrat, mink, and beaver.

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 and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations 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 adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (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 gravel, 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 10 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 generally are 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 gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills generally are limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties. site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, 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 11 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 generally are 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 11 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 cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface (25). There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage 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 11 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 offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as *a probable* or *improbable* source of sand and gravel. The ratings are based on

soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction. minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table. and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel, or both. They have at least 5 feet of suitable material, 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 gravel are used in many kinds of construction. Specifications for each use *vary* widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the taxonomic unit descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as *a probable* source has a layer of clean sand or gravel or a layer of sand or gravel that is 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 gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments. slope, a water table, soil texture. and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel. Stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils generally is 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 13 gives information on the soil properties and

site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds. The limitations are considered *slight* if soil properties and site features generally are 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, 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 more than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

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

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 cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

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

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features listed in tables are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. 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. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution and plasticity.

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 (22). Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits. the engineering 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 14 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 to 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 taxonomic unit 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 (1) and the Unified soil classification system (2). Both systems are described in the PCA Soil Primer (14).

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, SP-SM.

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.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

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 15 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 taxonomic unit 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 adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

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,* more than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil

to sheet and rill erosion. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average 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 (as much as 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.

Erosion factor T is an estimate of the maximum average 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 15, 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

Table 16 and 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are 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 (21).

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 sand or gravelly sand. 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 clay that has 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 covering of the soil surface by flowing water, is caused by overflow from streams, by runoff from adjacent slopes, or by inflow from high tides. Shallow water standing or flowing for short periods after rainfall or snowmelt is not considered to be flooding. Standing water in swamps and marshes or in closed depressional areas is considered to be ponding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely to occur.

Frequency, duration, and probable period of flooding are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable, *rare* that it is unlikely but is possible under unusual weather conditions (chance of flooding in any year is 0 to 5 percent), *occasional* that it occurs infrequently under normal weather conditions (chance of flooding in any year is 5 to 50 percent), and *frequent* that it occurs often under normal weather conditions (chance of flooding in any year is more than 50 percent).

Duration is expressed as *very brief* (less than 2 days), *brief (2* to 7 days), *long (7* days to 1 month), and *very long* (more than 1 month). The time of year that flooding is most likely to occur is expressed in months. November-May, for example, means that flooding can occur during the period November through May. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information on flooding is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons, which are characteristic of soils that are not subject to flooding.

Also considered are local information about the extent and level 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.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (24). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. 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 Xerumbrepts *(Xer,* meaning moist in winter and dry in summer, plus *umbrept,* the suborder of the Inceptisols that has 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 Xerumbrepts.

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, thickness 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 Xerumbrepts.

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 unit. A pedon, a small three-dimensional area of soil, that is typical of the unit in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (19).* Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (24).* 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 unit.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Alderwood Series

The Alderwood series consists of moderately deep,, moderately well drained soils on glacial till plains. These soils formed in glacial till. Slope is 0 to 50 percent. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 60 inches, the average annual temperature is about 50 degrees F, and the average frost-free season is 165 to 200 days.

These soils are loamy-skeletal, mixed, mesic Dystric Entic Durochrepts.

Typical pedon of Alderwood gravelly sandy loam, 3 to 15 percent slopes, 2 miles west of Olympia; about 1,950 feet east and 2,350 feet south of the northwest corner of sec. 17, T. 18 N., R. 2 W.

A-0 to 6 inches; very dark brown (10YR 2/2) gravelly sandy loam, dark brown (7.5YR 3/4) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many coarse, medium, and fine roots; many very fine interstitial pores; 20 percent pebbles; slightly acid; abrupt smooth boundary.

Bw1-6 to 15 inches; dark brown (7.5YR 3/4) gravelly sandy loam, yellowish brown (10YR 5/6) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many coarse and medium roots; many fine tubular pores; 30 percent pebbles; slightly acid; clear smooth boundary.

Bw2-15 to 30 inches; dark brown (7.5YR 3/4) very gravelly sandy loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable. nonsticky and nonplastic; common coarse and medium roots; many fine tubular pores; 40 percent pebbles; slightly acid; abrupt smooth boundary.

Bqm-30 inches; a dark grayish brown (2.5Y 4/2), weakly cemented duripan that crushes to very gravelly loamy sand; light brownish gray (10YR 6/2) dry; massive; extremely hard, extremely firm, nonsticky and nonplastic; 55 percent pebbles; slightly acid.

Depth to the weakly cemented, strongly compacted Bqm horizon ranges from 20 to 40 inches. The content of rock fragments in the control section ranges from 35 to 40 percent. The lower part of the subsoil is very gravelly sandy loam or very gravelly loam. The soils are strongly acid to slightly acid throughout.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 2 to 4 when moist or dry. The Bw horizon has hue of 10YR or 7.5YR and value and chroma of 3 to 6 when moist or dry. The Bqm horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist or dry, and chroma of 2 or 3 when moist or dry. It is mottled in some areas. It is very gravelly sandy loam or very gravelly loamy sand.

Baldhill Series

The Baldhill series consists of deep, well drained soils on terminal moraines. These soils formed in glacial drift. Slope is 0 to 60 percent. Elevation is 400 to 700 feet. The average precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are loamy-skeletal, mixed, mesic Dystric Xerochrepts.

Typical pedon of Baldhill very stony sandy loam, 30 to 60 percent slopes, 8 miles southeast of Yelm; about 400 feet west and 200 feet north of the southeast corner of sec. 29, T. 16 N., R. 3 E.

A-0 to 4 inches; dark brown (10YR 3/3) very stony sandy loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; common very fine and fine interstitial pores; 3 to 25 percent stones on the surface; 25 percent pebbles; medium acid; clear smooth boundary.

BA-4 to 12 inches; dark yellowish brown (10YR 4/4) very stony sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many very fine and fine interstitial pores; 25 percent stones and 15 percent pebbles; medium acid; gradual wavy boundary.

Bw1-12 to 29 inches; dark brown (10YR 4/3) very stony sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 25 percent stones and 25 percent pebbles; medium acid; gradual wavy boundary.

Bw2-29 to 36 inches; olive brown (2.5Y 4/4) very gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few medium roots; many very fine and fine interstitial pores; 35 percent pebbles; slightly acid; clear wavy boundary.

Bw3-36 to 45 inches; olive brown (2.5YR 4/4) very

gravelly sandy loam, pale brown (10YR 6/3) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few medium roots; many very fine and fine interstitial pores; 50 percent pebbles; slightly acid; clear wavy boundary.

Bw4-45 to 54 inches; dark yellowish brown (10YR 4/4) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; many very fine and fine interstitial pores; 65 percent pebbles; neutral; abrupt wavy boundary.

C-54 to 60 inches; dark yellowish brown (10YR 4/6) very gravelly loamy sand, yellowish brown (10YR 5/8) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine interstitial pores; 50 percent pebbles; neutral.

The particle-size control section is 10 to 25 percent stone-sized fragments and 20 to 45 percent pebbles.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is slightly acid or medium acid. The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is slightly acid or medium acid in the upper part and neutral to medium acid in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 8 when moist or dry.

Baumgard Series

The Baumgard series consists of deep, well drained soils on uplands. These soils formed in residuum and colluvium derived from andesite. Slope is 10 to 65 percent. Elevation is 400 to 1,600 feet. The average annual precipitation is 55 to 65 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 150 to 175 days.

These soils are fine-loamy, mixed, mesic Typic Xerumbrepts.

Typical pedon of Baumgard loam, 10 to 40 percent slopes, 8 miles southeast of Bucoda; about 1.200 feet east and 2,500 feet north of the southwest corner of sec. 21. T. 15 N., R. 1 E.

A1-0 to 8 inches; dark reddish brown (5YR 3/3) loam, reddish brown (5YR 4/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine tubular pores; medium acid; clear wavy boundary.

A2-8 to 14 inches; dark reddish brown (5YR 3/3) loam, reddish brown (5YR 5/3) dry; moderate fine subangular blocky structure; hard. friable, slightly sticky and slightly plastic; many medium and coarse roots; many very fine and fine tubular pores; 5 percent pebbles; medium acid; clear irregular boundary.

BA-14 to 25 inches; reddish brown (5YR 4/3) clay loam, light reddish brown (5YR 6/3) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common fine and medium roots; common fine and medium tubular pores; 5 percent pebbles; strongly acid; gradual wavy boundary.

Bw-25 to 30 inches; yellowish red (5YR 4/6) clay loam, light reddish brown (5YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; 10 percent pebbles; strongly acid; clear wavy boundary.

BC-30 to 45 inches; dark yellowish brown (10YR 4/4) very gravelly clay loam, pale brown (10YR 6/3) dry; massive; hard, firm, sticky and plastic; few fine tubular pores; 40 percent pebbles; strongly acid; clear irregular boundary.

R-45 inches; fractured andesite.

The depth to bedrock ranges from 40 to more than 60 inches. The content of rock fragments in the particle-size control section ranges from 5 to 35 percent. The fragments are dominantly pebbles, but a few are cobbles.

The A horizon has hue of 5YR 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 BA and Bw horizons have hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist and 3 or 4 when dry. They are clay loam or gravelly clay loam. The content of pebbles and cobbles in these horizons ranges from 5 to 25 percent. The BC horizon is gravelly clay loam or very gravelly clay loam.

Bellingham Series

The Bellingham series consists of very deep, poorly drained soils in depressions. Drainage has been altered by tiling and open ditches. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 400 feet. The average annual precipitation is 35 to 60

Inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 150 to 200 days.

These soils are fine, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Bellingham silty clay loam, 8 miles northwest of Olympia; about 2,100 feet east and 400 feet south of the northwest corner of sec. 34, T. 19 N., R.3W.

Ap-0 to 5 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; strong fine granular structure; hard, friable, sticky and plastic; many fine roots; medium acid; abrupt smooth boundary.

Bg1-5 to 8 inches, gray (5Y 5/1) silty clay., light gray (N 7/0) dry; few fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure; very hard, firm, sticky and plastic;; many fine roots;; many medium tubular and vesicular pores; medium acid; clear smooth boundary.

Bg2-8 to 14 inches; dark gray (5Y 4/1) silty clay, light gray (N 7/0) dry; few fine distinct yellowish brown (10YR 5/8) mottles; moderate medium prismatic structure; very hard, firm, very sticky and very plastic; common fine roots; many medium tubular and interstitial pores; thin patchy clay films on faces of peds and lining pores; slightly acid; clear smooth boundary.

Bg3-14 to 22 inches; gray (5Y 5/1) clay, light gray (N 7/0) dry; many medium distinct yellowish brown (10YR 5/8) mottles; moderate medium prismatic structure; very hard, firm, very sticky and very plastic; common fine roots; many medium tubular and interstitial pores; continuous pressure faces on peds; slightly acid; clear smooth boundary.

Bg4-22 to 48 inches; dark gray (5Y 4/1) clay, white (5Y 811) dry; many medium distinct yellowish brown (10YR 5/8) mottles; moderate medium prismatic structure; very hard, firm, very sticky and plastic; few fine roots; few medium tubular and interstitial pores; continuous pressure faces on peds; neutral; gradual smooth boundary.

Bg5-48 to 60 inches; gray (5Y 5/1) silty clay, white (5Y 8/1) dry; many medium distinct yellowish brown (10YR 5/8) mottles; moderate medium prismatic structure; very hard, firm, very sticky and very plastic; common fine roots; many medium tubular and interstitial pores; continuous pressure faces on peds; slightly acid.

The particle-size control section is 40 to 60 percent clay. The A horizon has value of 2 or 3 when moist and 3 or 4 when dry and chroma of 1 or 2. It has dark brown mottles in some areas. It is medium acid or slightly acid. The Bg horizon has hue of 5Y, 5BG, or 5GY, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 0 to 2. It has few to many, fine and medium mottles. It is silty clay or clay. Weak or distinct pressure faces are on some peds. This horizon is slightly acid or neutral.

Boistfort Series

The Boistfort series consists of very deep, well drained soils on uplands. These soils formed in material weathered from basalt. Slope is 5 to 40 percent. Elevation is 300 to 1,800 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Boistfort silt loam, 5 to 20 percent slopes, 5 miles northwest of Littlerock; about 1,800 feet west and 600 feet north of the southeast corner of sec. 24, T. 17 N., R. 4 W.

Oi-2 inches to 0; twigs, needles, and some moss.

A1-0 to 9 inches; dark brown (7.5YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many coarse, medium, and fine roots; many medium tubular pores; 25 percent firm shotlike concretions; very strongly acid; clear wavy boundary.

A2-9 to 19 inches; dark brown (7.5YR 3/2) silty clay loam, dark brown (10YR 4/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, sticky and plastic; weakly smeary; many coarse, medium, and fine roots; many medium tubular pores; few firm shotlike concretions; very strongly acid; clear wavy boundary.

Bw1-19 to 37 inches; dark brown (7.5YR 4/4) silty clay, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; few fine roots; common medium tubular and interstitial pores; extremely acid; gradual wavy boundary.

Bw2-37 to 53 inches; strong brown (7.5YR 5/6) silty clay, yellowish brown (10YR 5/8) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; few roots; few fine tubular pores and common medium interstitial pores; extremely acid; gradual wavy boundary.

BC-53 to 60 inches; strong brown (7.5YR 5/6) silty

clay, yellowish brown (10YR 5/6) dry; weak very fine subangular blocky structure; very hard, friable, sticky and plastic; weakly smeary; few fine tubular pores and common medium interstitial pores; extremely acid.

The thickness of the solum ranges from 40 to more than 60 inches, and the depth to basalt is more than 60 inches. The content of rock fragments ranges from 0 to 35 percent and averages less than 10 percent. The umbric epipedon is 10 to 20 inches thick.

The A horizon generally has value and chroma of 2 or 3 when moist or dry; however, value and chroma are one unit higher in some areas. The content of firm shotlike concretions in this horizon is 15 to 35 percent. Reaction is strongly acid or very strongly acid. The B horizon has hue of 5YR or 7.5YR when moist and value and chroma of 4 to 6. It is dominantly clay loam, silty clay loam, or silty clay, but some thin subhorizons are the gravelly or cobbly analogs of silty clay loam, clay loam. or silty clay. This horizon is very strongly acid or extremely acid.

Bunker Series

The Bunker series consists of deep, well drained soils on uplands. These soils formed in colluvial basalt. Slope is 5 to 65 percent. Elevation is 500 to 2,200 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 150 to 175 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Bunker gravelly silt loam, 5 to 30 percent slopes, 6 miles northwest of Littlerock; about 1,300 feet east and 2,200 feet north of the southwest corner of sec. 14, T. 17 N., R. 4 W.

Oi-2 inches to 0; twigs, needles, and some moss.

A-0 to 10 inches; dark reddish brown (5YR 3/3) gravelly silt loam, reddish brown (5YR 4/4) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; common fine and very fine pores; 20 percent angular basalt pebbles; medium acid; clear wavy boundary.

Bw1-10 to 17 inches; dark reddish brown (5YR 3/4) gravelly silt loam, reddish brown (5YR 4/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; common very fine and fine pores; 25 percent angular basalt pebbles; medium acid; clear irregular boundary.

Bw2-17 to 30 inches; reddish brown (5YR 4/4) gravelly silt loam, strong brown (7.5YR 5/6) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common fine pores; 30 percent angular basalt pebbles; medium acid; gradual wavy boundary.

Bw3-30 to 54 inches; reddish brown (5YR 4/4) gravelly silt loam, strong brown (7.5YR 5/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; common fine pores; 35 percent angular basalt pebbles; medium acid; gradual wavy boundary.

R-54 inches; fractured basalt.

The depth to fractured bedrock ranges from 40 to more than 60 inches. Reaction ranges from very strongly acid to medium acid throughout the profile. The content of rock fragments in the particle-size control section ranges from 15 to 35 percent.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist and 3 or 4 when dry. The content of pebbles in this horizon is 0 to 15 percent. The B horizon has hue of 5YR to 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist and 3 to 6 when dry. It is gravelly loam, gravelly clay loam, gravelly silt loam, or gravelly silty clay loam.

Cagey Series

The Cagey series consists of very deep, moderately well drained soils on terraces. These soils formed in sandy glacial drift. Slope is 0 to 4 percent. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 60 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 200 days.

These soils are mixed, mesic Aquic Xeropsamments.

Typical pedon of Cagey loamy sand, 3 miles south of Tumwater; about 1,600 feet west and 200 feet north of the southeast corner of sec. 16. T. 17 N., R. 2 W.

Ap-0 to 6 inches; dark brown (10YR 3/3) loamy sand, brown (10YR 5/3) dry; single grained; loose; many fine roots; many very fine pores; slightly acid; abrupt smooth boundary.

Bw-6 to 28 inches; dark yellowish brown (10YR 4/4) loamy sand, pale brown (10YR 6/3) dry; single grained; loose; common fine roots; many very fine

pores; slightly acid; abrupt wavy boundary.

C1-28 to 34 inches; light olive brown (2.5Y 5/4) fine sand, light brownish gray (2.5Y 6/2) dry; massive; loose, very friable, nonsticky and nonplastic; few fine roots; many very fine pores; slightly acid; abrupt wavy boundary.

C2-34 to 60 inches; light olive brown (2.5Y 5/4) fine sand, pale olive (5Y 6/3) dry; many fine distinct strong brown (7.5YR 5/8) mottles; massive; loose, very friable, nonsticky and nonplastic; few fine roots; many very fine pores; slightly acid.

The soils are slightly acid or neutral throughout. The A or Ap 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 or 3 when moist or dry. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 when dry, and chroma of 4 or 5 when moist and 2 or 3 when dry. In some areas it is mottled in the lower part. It is sand, fine sand, or loamy sand. The C horizon has hue of 2.5Y or 5Y when moist or dry and chroma of 2 to 4 when moist or dry. It is fine sand or sand.

Cathcart Series

The Cathcart series consists of deep, well drained soils on uplands. These soils formed in glacial drift, volcanic ash, and material weathered from sandstone and siltstone. Slope is 3 to 35 percent. Elevation is 100 to 900 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 160 to 200 days.

These soils are medial, mesic Andic Xerochrepts.

Typical pedon of Cathcart gravelly loam, 3 to 15 percent slopes, 3 miles southwest of Maytown; about 600 feet east and 850 feet south of the northwest corner of sec. 18, T. 16 N., R. 2 W.

A-0 to 4 inches; dark brown (10YR 3/3) gravelly loam, dark yellowish brown (10YR 4/4) dry; strong fine and medium granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine tubular pores; 25 percent rounded pebbles; medium acid; clear wavy boundary.

BA-4 to 12 inches; dark brown (7.5YR 3/4) gravelly loam, dark yellowish brown (10YR 4/4) dry; strong fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine tubular pores; 20 percent rounded pebbles; medium acid; gradual wavy boundary.

Bw1-12 to 25 inches; reddish brown (5YR 4/4) silt loam, strong brown (7.5YR 5/6) dry; strong medium and coarse subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; common fine and medium roots; common very fine and fine tubular pores; 10 percent rounded pebbles; medium acid; gradual wavy boundary.

Bw2-25 to 33 inches; yellowish red (5YR 4/6) silt loam, strong brown (7.5YR 5/8) dry; moderate medium and coarse subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; few fine roots; common fine interstitial pores; medium acid; gradual wavy boundary.

C-33 to 44 inches; reddish brown (2.5YR 4/4) clay loam, red (2.5YR 4/6) dry; many large prominent brown (10YR 5/3) mottles; moderate medium and coarse subangular blocky structure; hard, friable, sticky and plastic; few fine interstitial pores; 10 percent soft siltstone fragments; medium acid; gradual wavy boundary.

Cr-44 inches; weathered siltstone.

The depth to paralithic contact ranges from 40 to 60 inches. The content of hard rock fragments in the control section is less than 15 percent by weighted average.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist or dry, and chroma of 3 to 6 when moist or dry. It is strongly acid or medium acid. The B horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 or 5 when dry, and chroma of 4 to 6 when moist and 4 to 8 when dry. It is loam or silt loam and is strongly acid or medium acid. The C horizon varies widely in color and texture, depending on the type of bedrock. This horizon has hue of 2.5YR to 2.5Y.

Centralia Series

The Centralia series consists of very deep, well drained soils on uplands. These soils formed in material weathered from sandstone. Slope is 8 to 60 percent. Elevation is 200 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine-loamy, mixed, mesic Ultic Haploxeralfs.

Typical pedon of Centralia silt loam, 15 to 30 percent

slopes. 4 miles southwest of Bucoda; about 1,150 feet east and 1,450 feet north of the southwest corner of sec. 16, T. 15 N.. R. 2 W.

Oi-2 inches to 0; needles, leaves, and twigs.

A1-0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine. fine, and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many very fine interstitial and tubular pores; medium acid; clear smooth boundary.

A2-5 to 10 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common medium and coarse and many very fine and fine roots; common medium and many very fine tubular pores; medium acid; clear smooth boundary.

BA-10 to 15 inches; dark brown (10YR 4/3) clay loam, light yellowish brown (10YR 6/4) dry. moderate coarse subangular blocky structure; hard, friable, sticky and plastic; common very fine, medium, and coarse roots; common medium and many very fine tubular pores; medium acid; gradual wavy boundary.

Bt1-15 to 21 inches; dark brown (7.5YR 4/4) clay loam, reddish yellow (7.5YR 6/6) dry; moderate medium and coarse subangular and angular blocky structure; hard, firm, sticky and plastic; common very fine, fine, medium, and coarse roots; common medium and many very fine tubular pores; few thin clay films on faces of peds and lining pores; medium acid; gradual wavy boundary.

Bt2-21 to 35 inches; dark brown (7.5YR 4/4) clay loam, yellowish brown (10YR 5/6) dry; moderate medium and coarse angular blocky structure; hard, firm, sticky and plastic; common very fine, fine, medium, and coarse roots; many very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; medium acid; clear wavy boundary.

Bt3-35 to 42 inches; dark yellowish brown (10YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; moderate medium and coarse angular blocky structure; hard, firm, sticky and plastic; common very fine. fine, medium, and coarse roots; many *very* fine and fine tubular pores; many moderately thick clay films on faces of peds and lining pores; medium acid; clear wavy boundary.

BCt-42 to 60 inches; dark yellowish brown (10YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; weak medium and coarse blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine and fine tubular pores; continuous moderately thick and thick clay films on fragments of sandstone; 20 percent soft sandstone chips; strongly acid.

The umbric epipedon is 10 to 20 inches thick. The particle-size control section is 27 to 35 percent clay and more than 15 percent material that is coarser than very fine sand. The argillic horizon is more than 22 inches thick. Hue is 10YR or 7.5YR throughout the profile.

The A horizon has value of 2 or 3 when moist and chroma of 2 or 3 when moist or dry. It is slightly acid to strongly acid. The Bt horizon has value of 4 or 5 when moist and 5 or 6 when dry and chroma of 3 or 4 when moist and 4 to 6 when dry. It is silty clay loam or clay and is medium acid or strongly acid. The BCt horizon has value of 4 or 5 when moist and 5 or 6 when dry and chroma of 2 to 4 when moist or dry. It is silty clay loam or clay loam. It has visible mica chips and sand grains in most places. It is 0 to 35 percent soft, pebble-sized fragments of sandstone. It is strongly acid or very strongly acid. In some areas there are mottles that have hue of 10YR or 7.5YR, value of 4 or 5 when moist or dry, and chroma of 4 to 6 when moist or dry.

Chehalis Series

The Chehalis series consists of very deep, well drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 2 percent. Elevation is 100 to 200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine-silty, mixed, mesic Cumulic Ultic Haploxerolls.

Typical pedon of Chehalis silt loam, 3 miles west of Rochester; about 2,250 feet south and 200 feet west of the northeast corner of sec. 2, T. 15 N., R. 4 W.

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; strong fine and medium granular structure; hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

A-7 to 25 inches; dark brown (10YR 3/3) silty clay loam, dark yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very

fine roots; common very fine and fine tubular pores; medium acid; abrupt smooth boundary.

Bw1-25 to 33 inches; dark yellowish brown (10YR 3/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; few fine roots; common very fine and fine tubular pores; medium acid; abrupt smooth boundary.

Bw2-33 to 44 inches; dark brown (7.5YR 4/2) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine tubular pores; medium acid; clear wavy boundary.

C-44 to 60 inches; dark brown (7.5YR 3/4) loam, yellowish brown (10YR 5/6) dry; massive; soft, very friable, slightly sticky and slightly plastic; many very fine and fine tubular pores; medium acid.

The mollic epipedon is 24 to more than 60 inches thick. The particle-size control section is silty clay loam and is 25 to 30 percent clay. Hue ranges from 2.5Y to 7.5YR throughout the profile.

The A or Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 2 or 3 when moist or dry. It is slightly acid or medium acid. The Bw1 horizon has value of 2 or 3 when moist and 4 or 5 when dry. The Bw2 horizon has value of 2 to 4 when moist and 4 to 6 when dry and chroma of 2 or 3 when moist or dry. The Bw horizon is heavy silt loam or silty clay loam. It ranges from neutral to medium acid. The C horizon has value of 3 or 4 when moist and 5 or 6 when dry and chroma of 3 or 4 when moist and dry. It is neutral to medium acid and is silt loam, loam, or fine sandy loam.

Delphi Series

The Delphi series consists of deep, well drained soils on glacial uplands. These soils formed in continental glacial till. Slope is 3 to 30 percent. Elevation is 100 to 1,000 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 165 to 195 days.

These soils are medial-skeletal, mesic Andic Xerumbrepts.

Typical pedon of Delphi very gravelly loam, 3 to 15 percent slopes, 11 miles west of Olympia; about 1,700 feet west and 1,400 feet south of the northeast corner of sec. 19. T. 18 N., R. 3 W.

Oi-2 inches to 1 inch; needles, leaves, wood, and bark.

Oe-1 inch to 0; partially decomposed needles, wood, and bark.

A-0 to 8 inches; dark reddish brown (5YR 3/3) very gravelly loam, dark brown (10YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; 40 percent rounded glacial gravel, which includes 20 percent shot-sized concretions; many coarse, medium, and fine roots; medium acid; clear smooth boundary.

AB-8 to 13 inches; dark brown (7.5YR 3/2) very gravelly loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; 40 percent rounded glacial gravel; many coarse, medium, and fine roots; medium acid; clear smooth boundary.

Bw1-13 to 31 inches; dark yellowish brown (10YR 4/4) very gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; weakly smeary; 40 percent rounded glacial pebbles; common medium and fine roots; strongly acid; clear smooth boundary.

Bw2-31 to 48 inches; dark yellowish brown (10YR 4/4) extremely gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; 60 percent rounded glacial pebbles; about 20 percent clay; few fine roots; strongly acid; clear smooth boundary.

2Bqm-48 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly clay loam, yellowish brown (10YR 5/4) dry; massive; very hard, very firm; weakly cemented; 70 percent rounded glacial pebbles; strongly acid.

Depth to the cemented till ranges from 40 to 55 inches. The control section is silt loam or loam and is 35 to 70 percent rock fragments.

The A horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. The AB horizon is very gravelly silt loam or very gravelly loam. The A and AB horizons are medium acid or strongly acid.

The Bw horizon has hue of 7.5YR or 10YR when moist and value of 4 to 6 when dry. It is very gravelly silt loam, very gravelly loam, extremely gravelly loam, or extremely gravelly silt loam. The Bqm horizon is compact and weakly cemented, it is extremely gravelly clay loam or extremely gravelly loam in the upper 2 feet and extremely gravelly loamy sand in the lower part.

Dupont Series

The Dupont series consists of very deep, very poorly drained soils in depressions on uplands. Drainage has been altered by tiling and open ditches. These soils formed in organic deposits. Slope is 0 to 1 percent. Elevation is 50 to 350 feet. The average annual precipitation is 40 to 60 inches, the average air temperature is about 50 degrees F, and the average frost-free season is 150 to 190 days.

These soils are diatomaceous, euic, mesic Limnic Medisaprists,

Typical pedon of Dupont muck, 5 miles west of Yelm; about 500 feet east and 1,000 feet south of the northwest corner of sec. 17, T. 17 N., R. 1 E.

Op-0 to 7 inches; dark brown (10YR 3/3) sapric material, light brownish gray (10YR 6/2) dry; about 12 percent fiber, less than 5 percent rubbed; strong fine subangular blocky structure; hard, friable, nonsticky and nonplastic; many fine roots; about 15 percent volcanic ash and diatomaceous earth; very strongly acid; abrupt smooth boundary.

C-7 to 17 inches; dark grayish brown (10YR 4/2) volcanic ash and diatomaceous earth lenses, light gray (2.5Y 7/2) dry; strong medium angular blocky structure; slightly hard, firm, nonsticky and nonplastic; few fine roots; mixed with common discontinuous horizontal lenses of muck about ¼ inch thick; very strongly acid; abrupt smooth boundary.

Oa1-17 to 26 inches; dark reddish brown (5YR 3/2) sapric material, very dark grayish brown (10YR 3/2) dry; about 25 percent fiber, less than 5 percent rubbed; massive; soft, friable, nonsticky and nonplastic; few fine roots; strongly acid; abrupt smooth boundary.

Oa2-26 to 52 inches; dark reddish brown (5YR 3/2) sapric material, gray (10YR 5/1) dry; massive; soft, very friable. nonsticky and nonplastic; about 30 percent fiber, less than 10 percent rubbed; strongly acid; abrupt smooth boundary.

C'-52 to 54 inches; white (2.5Y 8/2) silt (mixed volcanic ash and diatomaceous earth), white (N 8/0) dry; massive; soft, friable, nonsticky and nonplastic; strongly acid; abrupt smooth boundary.

Oa'-54 to 60 inches; dark reddish brown (5YR 3/2) sapric material, gray (10YR 5/1) dry; about 25 percent fiber, less than 10 percent rubbed; massive; hard, friable, nonsticky and nonplastic; strongly acid.

The organic material ranges from 52 inches to more than 10 feet in thickness. The depth to limnic material is 7 to 20 inches near the perimeter of most bogs and 20 to 50 inches near the center. These soils are mostly decomposed spirea, sedges, and grasses. The control section is sapric material with an unrubbed fiber content of 20 to 40 percent and a rubbed fiber content of 10 to less than 5 percent. The limnic material is mixed diatomaceous earth and volcanic ash 2 to 10 inches thick. It has hue of 7.5YR to 2.5Y, value of 3 to 8, and chroma of 0 to 3. The organic material has hue of 10YR or 5YR. The soils are strongly acid or very strongly acid throughout.

Eld Series

The Eld series consists of very deep, well drained soils on alluvial fans and flood plains. These soils formed in alluvium. Slope is 0 to 5 percent. Elevation is 150 to 250 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine-loamy, mixed, mesic Cumulic Ultic Haploxerolls.

Typical pedon of Eld loam, 1.5 miles northwest of Littlerock; about 800 feet east and 2,350 feet north of the southwest corner of sec. 35, T. 17 N., R. 3 W.

Ap-0 to 7 inches; dark reddish brown (5YR 3/3) loam, yellowish red (5YR 4/6) dry; strong fine and very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; common very fine and fine tubular pores; medium acid; abrupt smooth boundary.

AB-7 to 22 inches; dark reddish brown (5YR 3/3) loam, yellowish red (5YR 5/6) dry; moderate very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few medium and common very fine and fine tubular pores; medium acid; gradual wavy boundary.

Bw1-22 to 35 inches; dark brown (7.5YR 3/4) loam, strong brown (7.5YR 5/6) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine and fine tubular pores; medium acid; gradual wavy boundary.

Bw2-35 to 60 inches; dark brown (7.5YR 4/4) silt loam, strong brown (7.5YR 5/6) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine tubular pores; medium acid.

The solum ranges from 40 to more than 60 inches in thickness. These soils are slightly acid or medium acid throughout. In some areas the content of pebbles is as much as 15 percent.

The A horizon has hue of 10YR to 5YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 2 or 3 when moist and 2 to 6 when dry. It is silt loam or loam. The B horizon has hue of 5YR to 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist and 3 to 6 when dry. It is loam or silt loam in the upper part and silt loam or silty clay loam in the lower part.

Everett Series

The Everett series consists of very deep. somewhat excessively drained soils on glacial terraces, moraines, and terrace escarpments. These soils formed in glacial outwash. Slope is 0 to 50 percent. Elevation is 50 to 700 feet. The average annual precipitation is 35 to 45 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are sandy-skeletal, mixed, mesic Andic Xerochrepts.

Typical pedon of Everett very gravelly sandy loam, 3 to 15 percent slopes. 6 miles southeast of Olympia; about 1,100 feet east and 2,600 feet north of the southwest corner of sec. 35. T. 18 N., R. 1 W.

A-0 to 3 inches; dark reddish brown (5YR 2/2) very gravelly sandy loam, dark brown (10YR 4/3) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many very fine and fine interstitial pores; 35 percent rounded pebbles; very strongly acid; abrupt smooth boundary.

Bw-3 to 12 inches; dark brown (7.5YR 3/4) extremely gravelly sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many very fine interstitial pores; 65 percent rounded pebbles; medium acid; clear smooth boundary.

BC-12 to 20 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy sand, pale brown (10YR 6/3) dry; single grained; loose; common fine and medium roots; many very fine interstitial pores; 75 percent rounded pebbles; medium acid; clear smooth boundary.

C1-20 to 28 inches; olive brown (2.5Y 4/4) extremely gravelly loamy sand, grayish brown (2.5Y 5/2) dry; single grained; loose; common fine and medium roots; many very fine interstitial pores; 75 percent rounded pebbles; medium acid; clear smooth boundary.

C2-28 to 60 inches; dark grayish brown (2.5Y 4/2) extremely gravelly sand, gray (5Y 6/1) dry; single grained; loose; few fine roots; 85 percent rounded pebbles; slightly acid.

The solum ranges from 12 to 26 inches in thickness. The content of coarse fragments in the control section ranges from 50 to 80 percent. The soils are very strongly acid to medium acid throughout.

The A horizon has hue of 10YR to 5YR, value of 2 to 5 when moist, and chroma of 2 or 3 when moist or dry. Some pedons do not have an A horizon. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 6 when moist and 3 to 5 when dry, and chroma of 2 to 4 when moist or dry. It is very gravelly sandy loam or extremely gravelly sandy loam. The C horizon has hue of 10YR to 5Y, value of 4 to 6 when moist or dry, and chroma of 2 to 4 when moist or dry. It is extremely gravelly sand to extremely loamy sand.

Everson Series

The Everson series consists of deep, poorly drained soils in depressions on glacial terraces. Drainage has been altered by tiling and open ditches. These soils formed in alluvium or lacustrine deposits and glacial outwash. Slope is 0 to 2 percent. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are clayey over sandy or sandy-skeletal, mixed, nonacid, mesic Typic Humaquepts.

Typical pedon of Everson clay loam, 2 miles northwest of Maytown; about 2,300 feet west and 950 feet north of the southeast corner of sec. 32, T. 17 N., R. 2 W.

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; strong medium and coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine pores; strongly acid; abrupt smooth boundary.

Bg1-6 to 9 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; common fine prominent yellowish red (5YR 5/6) mottles;

strong medium and coarse granular structure; slightly hard, friable, sticky and plastic; many very fine and common medium roots; many very fine and fine pores; medium acid; abrupt wavy boundary.

Bg2-9 to 16 inches; very dark gray (10YR 3/1) silty clay, light gray (10YR 7/1) dry; many large prominent reddish brown (5YR 5/4) and light reddish brown (5YR 6/4) mottles; moderate medium and coarse subangular blocky structure; hard, firm. sticky and plastic; common very fine roots; common very fine and fine pores; medium acid; clear wavy boundary.

Bg3-16 to 25 inches; brown (10YR 5/3) clay. light brownish gray (10YR 6/2) dry; many large prominent yellowish red (5YR 5/6 and 4/8) mottles; weak medium and coarse subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; common very fine and fine pores; medium acid; clear wavy boundary.

Bg4-25 to 30 inches; grayish brown (2.5Y 5/2) clay loam, gray (5Y 61) dry; many large prominent reddish yellow (7.5YR 6/8), yellowish red (5YR 5/8), and brownish yellow (10YR 6/6) mottles; massive; hard, firm, sticky and plastic; many fine and very fine roots; few very fine and fine pores; medium acid; abrupt smooth boundary.

2Cg-30 to 60 inches; dark gray (5Y 4/1) sand, gray (5Y 6 1) dry; many large prominent strong brown (7.5YR 5/8) mottles; massive; soft, very friable, nonsticky and nonplastic; many very fine pores; strongly acid.

The upper part of the control section is 35 to 45 percent clay, and the lower part is 0 to 10 percent clay. The solum is 25 to 30 inches thick. By weighted average, the lower part of the control section is 0 to 10 percent pebbles. In some areas gravelly strata are below a depth of 40 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 or 2 when moist or dry. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay, clay loam, or clay. The C horizon has hue of 5Y or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It has mottles with hue of 7.5YR or 10YR. The fine-earth fraction of this horizon is loamy sand or sand.

Galvin Series

The Galvin series consists of very deep, somewhat poorly drained soils on alluvial fans and terraces. These soils formed in alluvium derived from shale and sandstone. Slope is 0 to 5 percent. Elevation is 150 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine-silty, mixed, mesic Aquic Palexeralfs.

Typical pedon of Galvin silt loam, 0 to 5 percent slopes, 2 miles northeast of Bucoda; about 900 feet west and 2,200 feet south of the northeast corner of sec. 5, T. 15 N., R. 1 W.

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine tubular pores; slightly acid; abrupt smooth boundary.

AB-7 to 12 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine pores; medium acid; clear smooth boundary.

Bt1-12 to 20 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; common medium prominent strong brown (7.5YR 5/6) mottles; moderate very coarse, coarse, and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; many thin and moderately thick clay films on faces of peds and lining pores; slightly acid; clear smooth boundary.

Bt2-20 to 35 inches; dark yellowish brown (10YR 4/4) silty clay loam, very pale brown (10YR 7/3) dry; many large prominent pale red (2.5YR 6/2) and strong brown (7.5YR 5/8) mottles; moderate very coarse, coarse, and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine and medium pores; many thin and moderately thick clay films on faces of peds and lining pores; medium acid; clear smooth boundary.

Bt3-35 to 60 inches; mixed light yellowish brown (10YR 6/4), grayish brown (2.5Y 5/2), and reddish yellow (7.5YR 6/8) silty clay, very pale brown (10YR 7/4), light yellowish brown (10YR 6/4), and reddish yellow (7.5YR 6/8) dry; strong coarse, medium, and fine angular blocky structure; very hard, firm, sticky

and plastic; few very fine roots; common very fine tubular pores; continuous thin and moderately thick clay films on faces of peds and lining pores; medium acid.

The solum ranges from 40 to more than 60 inches in thickness. The control section is loam, silt loam. or silty clay loam and is 23 to 35 percent clay.

The A horizon has hue of 10YR or 7.5YR, value of 2 to 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. The lower part of this horizon is silt loam or silty clay loam. The Bt horizon has prominent mottles with hue of 2.5YR to 7.5YR, value of 5 or 6 when moist and 4 to 6 when dry, and chroma of 2 to 8 when moist and 4 to 8 when dry.

Giles Series

The Giles series consists of deep, well drained soils on terraces and terrace escarpments. These soils formed in volcanic ash and glacial outwash. Slopes are 0 to 30 percent. Elevation is 50 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 170 to 200 days.

These soils are medial, mesic Andic Xerochrepts.

Typical pedon of Giles silt loam, 0 to 3 percent slopes, 1/2 mile southwest of East Olympia Station; about 1,900 feet west and 2,150 feet south of the northeast corner of sec. 18, T. 17 N., R. 1 W.

Oi-1 inch to 0; partially decomposed needles and twigs.

A-0 to 3 inches; dark brown (7.5YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium and fine roots; strongly acid; abrupt wavy boundary.

Bw1-3 to 10 inches; dark yellowish brown (10YR 4/4) silt loam, pale brown (10YR 6/3) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common medium and fine roots; medium acid; clear smooth boundary.

Bw2-10 to 48 inches; olive brown (2.5Y 4/4) silt loam, pale brown (10YR 6/3) dry; strong fine angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and fine roots; many medium tubular and interstitial pores; medium acid; abrupt smooth boundary.

C-48 to 60 inches; olive brown (2.5Y 4/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; soft, friable, slightly sticky and nonplastic; many medium tubular and interstitial pores; medium acid.

The A horizon has hue of 10YR or 7.5YR when moist and 10YR or 2.5Y when dry, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is strongly acid to slightly acid. Some pedons have an E horizon. The Bw horizon has hue of 10YR to 5Y, 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 fine sandy loam and is medium acid or slightly acid. The C horizon has hue of 5Y to 10YR, 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 sandy loam or silt loam or is stratified silt loam to sand. It is medium acid or slightly acid.

Godfrey Series

The Godfrey series consists of deep, poorly drained soils in depressions on flood plains. Drainage has been altered by tiling. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 200 feet. The average annual precipitation is 40 to 50 inches, the average annual temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine, mixed, nonacid. mesic Typic Fluvaquents.

Typical pedon of Godfrey silty clay loam, 1.5 miles southeast of Tumwater; about 700 feet east and 1,250 feet north of the southwest corner of sec. 36, T. 18 N., R. 2 W.

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, gray (10YR 5/1) dry; many fine distinct strong brown (7.5YR 5/8) and yellowish brown (10YR 5/8) mottles; strong coarse subangular blocky structure; hard, firm, sticky and plastic; many fine roots; many coarse, medium, and fine tubular pores and many coarse interstitial pores; very strongly acid; abrupt smooth boundary.

BA-8 to 11 inches; very dark gray (10YR 3/1) silty clay loam, gray (5Y 5/1) dry; common medium distinct strong brown (7.5YR 5/8) mottles; strong coarse angular blocky structure; hard, firm, sticky and plastic; many fine roots; many coarse, medium, and fine tubular pores and many coarse interstitial pores; medium acid; clear smooth boundary.

Bg-11 to 30 inches; dark gray (5Y 4/1) silty clay, gray (5Y 6/1) dry; common medium distinct strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky

and slightly plastic; few fine roots; many coarse, medium. and fine tubular pores and many coarse interstitial pores; slightly acid; abrupt smooth boundary.

Cg1-30 to 42 inches; dark gray (5Y 4/1) clay loam, gray (5Y 6/1) dry; many coarse distinct strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many coarse, medium, and fine tubular pores and many coarse interstitial pores; slightly acid; abrupt smooth boundary.

Cg2-42 to 52 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; many coarse distinct strong brown (7.5YR 5/8) mottles; moderate medium platy structure; hard, friable, sticky and plastic; few fine interstitial pores; slightly acid; abrupt smooth boundary.

Cg3-52 to 64 inches; dark gray (5Y 4/1) silty clay, gray (5Y 6/1) dry; few fine faint strong brown (7.5YR 5/8) mottles; massive; very hard, firm, sticky and plastic; few fine interstitial pores; slightly acid.

The particle-size control section does not include coarse fragments. It ranges from 35 to 50 percent clay.

The A horizon has value of 3 to 5 when moist and 5 or 6 when dry and chroma of 1 or 2 when moist or dry. It is very strongly acid or medium acid. The B horizon has hue of 10YR to 5Y, value of 3 or 4 when moist and 5 or 6 when dry. and chroma of 0 or 1 when moist or dry. It is silty clay loam, silty clay, or clay. It is medium acid or slightly acid. The C horizon has hue of 10YR to 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 0 to 2 when moist or dry. It is clay loam, silty clay, or silty clay loam. It is slightly acid or neutral.

Grove Series

The Grove series consists of very deep. somewhat excessively drained soils on terraces. These soils formed in glacial outwash. Slope is 3 to 15 percent. Elevation is 100 to 500 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

These soils are sandy-skeletal. mixed, mesic Dystric Xerorthents.

Typical pedon of the Grove very gravelly sandy loam, 3 to 15 percent slopes, 14 miles west of Olympia; about 2,500 feet north and 200 feet west of the southeast corner of sec. 9. T. 18 N., R. 4 W.

Oi-3 inches to 1 inch; needles, twigs, and leaves.

Oe-1 inch to 0; partially decomposed needles, twigs, and leaves.

Bw1-0 to 6 inches; dark reddish brown (5YR 3/2) very gravelly sandy loam, dark brown (7.5YR 4/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and common medium and coarse roots; common very fine pores; 45 percent rounded pebbles; medium acid; clear wavy boundary.

Bw2-6 to 21 inches; reddish brown (5YR 4/4) very gravelly loamy sand, strong brown (7.5YR 5/8) dry; single grained; loose, nonsticky and nonplastic; common very fine roots; common very fine pores; 55 percent pebbles; medium acid; gradual wavy boundary.

BC-21 to 36 inches; dark brown (7.5YR 4/4) very gravelly sand, yellowish brown (10YR 5/4) dry; single grained; loose, nonsticky and nonplastic; common very fine roots; common very fine pores; 60 percent rounded pebbles; medium acid; gradual wavy boundary.

C-36 to 60 inches; dark brown (10YR 4/3) extremely gravelly coarse sand, yellowish brown (10YR 5/4) dry; single grained; loose, nonsticky and nonplastic; few very fine roots; common very fine pores; 70 percent rounded pebbles; medium acid.

The content of coarse fragments in the control section exceeds 55 percent and is as much as 75 percent by volume. The fragments are dominantly gravel. Some pedons have a thin A horizon.

The Bw horizon has hue of 5YR or 7.5YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and 4 to 8 when dry. It is very gravelly loamy sand, very gravelly sand, or very gravelly sandy loam. The BC horizon has hue of 10YR or 7.5YR and value and chroma of 3 to 5. It is gravelly or extremely gravelly sand. The C horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 to 4. It is very gravelly sand or extremely gravelly sand.

Hoogdal Series

The Hoogdal series consists of moderately deep, moderately well drained soils on terraces and terrace escarpments. These soils formed in loess and glaciolacustrine sediment. Slope is 15 to 50 percent. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 51 degrees F, and the average frost-free period is 160 to 200 days.

These soils are fine, mixed, mesic Aquic Dystric Xerochrepts.

Typical pedon of Hoogdal silt loam, 30 to 50 percent slopes, 6 miles northwest of Olympia; about 1,150 feet north and 2.530 feet west of the southeast corner of sec. 18,T. 19 N., R. 1 W.

A-0 to 5 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine interstitial pores; medium acid; abrupt wavy boundary.

Bw1-5 to 10 inches; yellowish brown (10YR 5/6) silty clay loam, very pale brown (10YR 7/3) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; common fine and few medium and coarse roots; common very fine interstitial pores; medium acid; clear smooth boundary.

Bw2-10 to 25 inches; light yellowish brown (10YR 6/4) silty clay, white (10YR 8/2) dry; common fine faint light yellowish brown (2.5Y 6/4) mottles; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots; few fine tubular pores and common very fine interstitial pores; medium acid; clear smooth boundary.

C-25 to 60 inches; olive gray (5Y 4/2) silty clay, pale yellow (5Y 7/3) dry; few fine faint light yellowish brown (2.5Y 6 4) mottles; massive; hard, firm, very sticky and very plastic; very few interstitial pores; medium acid.

The thickness of the solum ranges from 17 to 30 inches. The A horizon has value of 3 or 4 when moist and 5 or 6 when dry and chroma of 2 or 3 when moist or dry. The Bw horizon has hue of 2.5Y to 10YR, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam, silty clay loam. or silty clay. The content of clay in this horizon ranges from 13 to 45 percent. The C horizon has value of 5 or 6 when moist and 6 to 8 when dry and chroma of 2 or 3 when moist or dry. It is silty clay or clay. The content of clay in this horizon ranges from 40 to 65 percent.

Indianola Series

The Indianola series consists of very deep, somewhat excessively drained soils on terraces, terrace escarpments, eskers. and kames. These soils formed in sandy glacial drift. Slope is 0 to 30 percent. Elevation is 50 to 700 feet. The annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Indianola loamy sand, 3 to 15 percent slopes, 2 miles southeast of Tumwater; about 2,200 feet east and 2,550 feet north of the southwest corner of sec. 1, T. 16 N., R. 2 W.

A-0 to 6 inches; dark reddish brown (5YR 3/3) loamy sand, brown (10YR 5/3) dry; weak coarse and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and few coarse and medium roots; common fine tubular pores; neutral; abrupt smooth boundary.

Bw-6 to 13 inches; dark reddish brown (5YR 3/4) loamy sand, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few medium roots; few fine tubular pores; neutral; clear smooth boundary.

BC-13 to 25 inches; dark brown (10YR 4/3) loamy sand, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 5 percent rounded pebbles; neutral; clear smooth boundary.

C1-25 to 35 inches; dark yellowish brown (10YR 4/4) sand, light brownish gray (2.5Y 6/2) dry; single grained;; loose; few very fine roots; few very fine tubular pores; 5 percent rounded pebbles; neutral; gradual wavy boundary.

C2-35 to 60 inches; olive brown (2.5Y 4/4) sand, light brownish gray (2.5Y 6/2) dry; single grained; loose; few very fine roots; many fine interstitial pores; 5 percent rounded pebbles; neutral.

Reaction is neutral or slightly acid throughout the profile. The content of rock fragments is 0 to 15 percent in the particle-size control section.

The A horizon has hue of 10YR to 5YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 1 to 3 when moist or dry. The Bw horizon has hue of 10YR to 5YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 1 to 4 when moist or dry. It is loamy fine sand or loamy sand. The BC horizon has hue of 10YR or 2.5Y, 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 loamy fine sand or loamy sand. The C horizon has hue of 10YR to 5Y, value of 4 to 6 when moist and 5 to 7

when dry, and chroma of 2 to 4 when moist or dry. It is loamy fine sand or sand.

Jonas Series

The Jonas series consists of deep, well drained soils on mountain slopes. These soils formed in colluvium and andesite residuum mixed with volcanic ash in the upper part. Slope is 30 to 65 percent. Elevation is 1,800 to 2,400 feet. The average annual precipitation is 60 to 75 inches. the average annual air temperature is about 43 degrees F, and the average frost-free season is 130 to 160 days.

These soils are medial, frigid Andic Haplumbrepts.

Typical pedon of Jonas silt loam, 30 to 65 percent slopes, 7 miles southeast of Vail; about 925 feet west and 1,600 feet north of the southeast corner of sec. 23, T. 15 N., R. 2 E.

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; weak fine and medium granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and common medium roots; many fine pores; 10 percent pebbles; medium acid; clear wavy boundary.

A2-4 to 14 inches; very dark brown (10YR 2/2) very cobbly silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium and few coarse roots; many fine pores; 30 percent cobbles and 25 percent pebbles; strongly acid; clear wavy boundary.

Bw1-14 to 25 inches; dark brown (10YR 3/3) cobbly loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and few medium roots; common fine and very fine pores; 10 percent cobbles and 15 percent pebbles; strongly acid; clear wavy boundary.

Bw2-25 to 42 inches; dark brown (10YR 4/3) cobbly clay loam. very pale brown (10YR 7/4) dry; weak coarse subangular blocky structure; hard. friable, slightly sticky and plastic; few fine and medium roots; 20 percent cobbles and 10 percent pebbles; few fine pores; strongly acid; clear wavy boundary.

BC-42 to 60 inches; dark yellowish brown (10YR 4/4) cobbly clay loam, very pale brown (10YR 7/4) dry; weak coarse subangular blocky structure; hard, friable, slightly sticky and plastic; few fine pores; 20 percent cobbles and 15 percent pebbles; strongly acid.

The depth to unweathered bedrock ranges from 40 to more than 60 inches. The content of rock fragments in the particle-size control section ranges from 15 to 35 percent, including 5 to 15 percent andesite pebbles and 5 to 20 percent andesite cobbles. The soils are strongly acid or medium acid throughout.

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 is silt loam or silty clay loam. The content of pebbles ranges from 15 to 30 percent in the upper part of this horizon. In the lower part, the content of andesite pebbles ranges from 25 to 30 percent and the content of andesite cobbles ranges from 10 to 30 percent. The B horizon is loam or silt loam.

Kapowsin Series

The Kapowsin series consists of moderately deep, moderately well drained soils on uplands. These soils formed in compact glacial till. Slope is 0 to 50 percent. Elevation is 50 to 600 feet. The average annual precipitation is 35 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial over loamy, mixed, mesic Dystric Entic Durochrepts.

Typical pedon of Kapowsin silt loam, 3 to 15 percent slopes, 7 miles northwest of Olympia; about 700 feet east and 350 feet north of the southwest corner of sec. 7, T. 19 N.. R. 2 W.

A-0 to 4 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard. very friable. slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; few very fine pores; 20 percent medium concretions; medium acid; abrupt smooth boundary.

BA-4 to 11 inches; dark yellowish brown (10YR 3/4) silt loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots; few very fine pores; 30 percent medium concretions; medium acid; gradual wavy boundary.

Bw1-11 to 18 inches; dark yellowish brown (10YR 4/4) silt loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic;

weakly smeary; common very fine. fine.. and medium roots; few very fine pores; 10 percent rounded pebbles; medium acid; clear wavy boundary.

Bw2-18 to 22 inches; dark yellowish brown (10YR 3/6) loam, light yellowish brown (10YR 6/4) dry; few fine faint yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine., fine, and medium roots; few very fine pores; medium acid; clear wavy boundary.

2Bw3-22 to 30 inches; dark yellowish brown (10YR 4/6) gravelly loam, pale brown (10YR 6/3) dry; few fine faint yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine pores; 20 percent pebbles; medium acid; clear wavy boundary.

2Bqm-30 to 60 inches; grayish brown (2.5Y 5/2) gravelly loam, light gray (2.5Y 7/2) dry; massive; weakly cemented; very compact in place; hard, firm. slightly sticky and slightly plastic; slightly acid.

The control section is 10 to 30 percent coarse fragments. 45 to 60 percent sand., and 6 to 15 percent clay. The solum has a few stones and cobbles throughout. Depth to the 2Bqm horizon ranges from 20 to 32 inches. The soils are medium acid or slightly acid throughout.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist, and chroma of 2 or 3 when moist. It is silt loam in which the content of concretions is 20 to 30 percent. The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 6 when moist, and chroma of 3 or 4 when moist. It is loam or silt loam. The 2Bqm horizon has value of 4 or 5 when moist and chroma of 2 to 4 when moist. It is mottled in some areas.

Katula Series

The Katula series consists of moderately deep,, well drained soils on uplands. These soils formed in material weathered from basalt. Slope is 20 to 65 percent. Elevation is 1,800 to 2,650 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 130 to 170 days.

These soils are medial-skeletal, mesic Andic Haplumbrepts.

Typical pedon of Katula very cobbly loam, 30 to 65 percent slopes, 6 miles northwest of Littlerock; about 900 feet east and 2,000 feet south of the northwest corner of sec. 1. T. 17 N., R. 4 W.

A-0 to 5 inches; dark reddish brown (5YR 3/3) very cobbly loam, dark brown (10YR 4/3) dry; strong medium and fine granular structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; many fine, common coarse, and few medium roots; many fine tubular pores; 35 percent cobbles and 20 percent pebbles; medium acid; clear smooth boundary.

AB-5 to 14 inches; dark brown (7.5YR 3/2) extremely cobbly loam, dark brown (10YR 4/3) dry; strong medium and fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; few coarse and medium and many very fine and fine roots; many fine tubular pores; 45 percent cobbles and 25 percent pebbles; medium acid; gradual smooth boundary.

Bw-14 to 32 inches; dark brown (7.5YR 3/2) extremely cobbly loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; common fine tubular pores; 50 percent cobbles and 25 percent pebbles; medium acid; abrupt smooth boundary.

R-32 inches; fractured basalt.

The depth to lithic contact ranges from 20 to 40 inches. Angular cobbles, pebbles, and stones make up, by volume, 60 to 80 percent of the control section. They are dominantly cobble-sized fragments. In some areas the content of shotlike concretions is as much as 30 percent in the upper part of the A horizon.

The A horizon has hue of 5YR to 10YR, value of 2 or 3 when moist and 2 to 4 when dry, and chroma of 2 or 3 when moist and 3 to 6 when dry. The content of cobbles in this horizon is 15 to 45 percent, and the content of pebbles is 20 to 35 percent. The Bw horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 or 5 when dry, and chroma of 2 to 6 when moist and 3 or 4 when dry. It is extremely cobbly clay loam or extremely cobbly loam.

Lates Series

The Lates series consists of moderately deep, well drained soils on mountains. These soils formed in material weathered from basalt. Slope is 8 to 65 percent. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 75 to 80 inches, the

average annual air temperature is about 43 degrees F, and the average frost-free season is 130 to 170 days.

These soils are medial, frigid Andic Haplumbrepts.

Typical pedon of Lates silt loam, 8 to 30 percent slopes, 6 miles northeast of Littlerock; about 500 feet east and 2,000 feet north of the southwest corner of sec. 1.T. 17N., R. 4 W.

A1-0 to 4 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 3/3) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots; many very fine and fine tubular pores; 5 percent pebbles; very strongly acid; abrupt wavy boundary.

A2-4 to 12 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 3/3) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and common coarse roots; common fine and medium tubular pores; 5 percent pebbles; very strongly acid; abrupt smooth boundary.

Bw1-12 to 22 inches; dark brown (7.5YR 3/4) gravelly loam, dark yellowish brown (10YR 4/6) dry; weak fine and medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; common very fine and fine tubular pores; 20 percent pebbles; strongly acid; abrupt irregular boundary.

Bw2-22 to 32 inches; dark yellowish brown (10YR 3/4) gravelly silt loam, dark yellowish brown (10YR 4/6) dry; moderate fine and medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; common very fine and fine tubular pores; 25 percent pebbles; strongly acid; abrupt irregular boundary.

R-32 inches; fractured basalt.

The depth to lithic contact ranges from 20 to 40 inches. The particle-size control section is dominantly gravelly loam in which the content of clay is 20 to 30 percent and the content of rock fragments is 15 to 30 percent.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 to 3 when moist and 2 to 4 when dry. It is strongly acid or very strongly acid. The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 to 6 when moist or dry. It is medium acid or strongly acid.

Mal Series

The Mal series consists of very deep, moderately well drained soils on foothills and mountain slopes. These soils formed in material weathered from tuffaceous marine siltstone and sandstone mixed with volcanic ash in the upper part. Slope is 5 to 65 percent. Elevation is 1,800 to 2,300 feet. The average annual precipitation is 60 to 70 inches,, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 150 days.

These soils are fine, mixed, frigid Ultic Haploxeralfs.

Typical pedon of Mal clay loam, 5 to 30 percent slopes, 14 miles southeast of Yelm; about 1,500 feet west and 1,000 feet south of the northeast corner of sec. 22, T. 15 N., R. 2 E.

A-0 to 7 inches; dark yellowish brown (10YR 4/6) clay loam, light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 10 percent pebbles; medium acid; clear wavy boundary.

Bt1-7 to 16 inches; dark brown (7.5YR 4/4) clay loam, pale brown (10YR 6/3) dry; moderate fine, medium, and coarse subangular blocky structure; slightly hard, friable, sticky and plastic; many fine roots; common very fine and fine tubular pores; 10 percent pebbles; strongly acid; gradual smooth boundary.

Bt2-16 to 35 inches; dark yellowish brown (10YR 4/6) clay, reddish yellow (7.5YR 6/6) dry; moderate medium, coarse, and very coarse subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and very fine roots; few very fine tubular pores; few thin clay films on faces of peds and lining pores; strongly acid; gradual wavy boundary.

Bt3-35 to 60 inches; strong brown (7.5YR 5/6) clay, reddish yellow (7.5YR 6/6) dry; moderate medium, coarse, and very coarse subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few very fine tubular pores; few thin clay films on faces of peds and lining pores; strongly acid.

The depth to weathered siltstone is more than 60 inches. The content of weathered, gravel-sized siltstone fragments in the particle-size control section is 0 to 15 percent. The soils are medium acid to very strongly acid throughout.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 2 to 4 when dry, and chroma of 2

to 6 when moist or dry. The Bt 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 heavy clay loam, heavy silty clay loam, silty clay, or clay. It has thin to thick, nearly continuous clay films on faces of peds and in pores. Some pedons have a C horizon, which is clay loam, silty clay loam, silty clay, or clay.

Mashel Series

The Mashel series consists of deep, moderately well drained soils on uplands. These soils formed in glacial till. Slope is 5 to 65 percent. Elevation is 900 to 1,500 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 190 days.

These soils are fine, halloysitic, mesic Ultic Haploxeralfs.

Typical pedon of Mashel loam, 5 to 30 percent slopes, 12 miles southeast of Yelm; about 800 feet east and 600 feet north of the southwest corner of sec. 14, T. 15 N., R. 3 E.

Oa-3 inches to 0; partially decomposed roots, leaves, and twigs.

A-0 to 8 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; few rounded pebbles; very strongly acid; clear smooth boundary.

BA-8 to 16 inches; dark brown (10YR 4/3) heavy loam, pale brown (10YR 6/3) dry; few fine faint dark brown (10YR 3/3) mottles; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many fine and medium roots; many fine pores; few rounded pebbles; thin patchy clay films on faces of some peds; very strongly acid; clear wavy boundary.

Bt-16 to 36 inches; yellowish brown (10YR 5/4) clay loam. light yellowish brown (10YR 6/4) dry; moderate medium and coarse subangular blocky structure; hard,, firm, sticky and plastic; common fine and medium roots; common fine and medium pores; 5 percent rounded, unweathered and weathered pebbles; many thin or moderately thick dark brown clay films on faces of peds and in pores; common uncoated silt and sand particles on faces of some peds and within some peds; few black stains; very strongly acid; gradual wavy boundary.

BCt-36 to 55 inches; yellowish brown (10YR 5/4) and light yellowish brown (10YR 6/4), very strongly weathered glacial till that is silty clay after prolonged rubbing; light gray (10YR 7/2) and very pale brown (10YR 7/3) dry; weak coarse subangular blocky structure; rock structure in 75 percent of the horizon; slightly hard, friable, sticky and plastic; few fine pores; continuous thick dark brown clay films in pores and along faces of fractures; few pebbles; many small pockets of dark brown clay; very strongly acid; gradual wavy boundary.

C-55 to 60 inches; mixed grayish brown (10YR 5/2) and light yellowish brown (10YR 6/4), strongly weathered glacial till that is loam after prolonged rubbing and exhibits rock structure; massive; slightly hard, friable, slightly sticky and slightly plastic; few pebbles; strongly acid.

The content of unweathered pebbles in the particle-size control section ranges from 0 to 10 percent. 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 or 3 when dry. The Bt horizon has hue of 10YR or 7.5YR and value of 4 or 5 when moist and 5 or 6 when dry. It has few or common black stains. In some pedons it has few or common, faint or distinct mottles. It is clay loam or silty clay loam. It has few to many uncoated particles of sand and silt occurring as thin coatings on faces of some peds. The BCt horizon is silty clay, silty clay loam, or clay loam. Thin lenses and pockets of dark brown clay make up to 5 to 20 percent of this horizon. Rounded pebbles make up 0 to 10 percent.

Maytown Series

The Maytown series consists of very deep, moderately well drained soils on flood plains. These soils formed in alluvium derived from glacial sediment. Slope is 0 to 2 percent. Elevation is 50 to 500 feet. The average annual precipitation is 50 to 65 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine-silty, mixed, mesic Fluventic Haploxerolls.

Typical pedon of Maytown silt loam, 4.5 miles southwest of Littlerock; about 300 feet west and 200 feet south of the northeast corner of sec. 20, T. 16 N., R. 3 W.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and

slightly plastic; many fine roots; very fine tubular pores; strongly acid; abrupt smooth boundary.

A-8 to 16 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard. friable, slightly sticky and slightly plastic; many fine roots; common very fine and fine tubular pores; strongly acid; clear smooth boundary.

Bw1-16 to 28 inches; brown (10YR 4/3) heavy silt loam, brown (10YR 5/3) dry; strong fine subangular blocky structure; hard, friable, sticky and plastic; common fine roots; common very fine and fine tubular pores; medium acid; gradual smooth boundary.

Bw2-28 to 36 inches; brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; strong fine subangular blocky structure; hard. friable, sticky and plastic; few fine roots; common very fine tubular pores; very strongly acid; gradual smooth boundary.

Bw3-36 to 60 inches; brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; few fine faint light brownish gray (2.5Y 6/2) mottles; strong fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; common fine tubular pores; very strongly acid.

Faint to distinct mottles are below a depth of 30 inches. Base saturation is 50 to 75 percent in the upper Winches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is strongly acid or medium acid. The Bw horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is dominantly silt loam or silty clay loam but has thin, discontinuous layers of fine sandy loam or silty clay in some areas. It is very strongly acid to slightly acid.

McKenna Series

The McKenna series consists of moderately deep, poorly drained soils in depressions and drainageways. These soils formed in glacial drift. Slope is 0 to 5 percent. Elevation is 50 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is 50 degrees F, and the average frost-free season is 150 to 180 days.

These soils are loamy-skeletal, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of McKenna gravelly silt loam, 0 to 5 percent slopes, 3 miles southwest of Olympia; about 1,900 feet west and 1,400 feet south of the northeast corner of sec. 8, T. 18 N., R. 2 W.

A-0 to 9 inches; black (10YR 2/1) gravelly silt loam, dark gray (10YR 4/1) dry; strong fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine and fine interstitial pores; 20 percent rounded pebbles; medium acid; abrupt smooth boundary.

BA-9 to 13 inches; very dark grayish brown (10YR 3,'2) gravelly silt loam. light brownish gray (10YR 6/2) dry; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine tubular pores; 25 percent rounded pebbles; medium acid; gradual smooth boundary.

Bw1-13 to 21 inches; very dark grayish brown (10YR 3/2) very gravelly silt loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; common very fine tubular pores; 35 percent rounded pebbles; medium acid; clear wavy boundary.

Bw2-21 to 28 inches; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; common medium distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few very fine tubular pores; 45 percent rounded pebbles; medium acid; clear wavy boundary.

Bw3-28 to 36 inches; dark yellowish brown (10YR 3/4) very gravelly loam, pale brown (10YR 6/3) dry; few fine faint yellowish brown (10YR 5/8) and olive gray (5Y 5/2) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few very fine tubular pores; 50 percent rounded pebbles; medium acid; abrupt smooth boundary.

Cr-36 to 60 inches; dark greenish gray (5BG 4/1) dense glacial till that crushes to very gravelly loam, gray (N 6/0) dry; massive; extremely hard, firm, nonsticky and nonplastic; 50 percent rounded pebbles; medium acid.

The thickness of the solum ranges from 20 to 40 inches. The particle-size control section ranges from 35 to 60 percent coarse fragments and 20 to 35 percent clay.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 2 to 5 when dry, and chroma of 1

or 2. It is strongly acid or medium acid. The Bw horizon has hue of 10YR to 5Y, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 1 or 2. It has coarse to fine, prominent to faint mottles. It is clay loam, loam, or silt loam. The content of coarse fragments in this horizon generally ranges from 35 to 60 percent, but in some areas it is less than 35 percent in the upper part. This horizon is strongly acid or medium acid. The Cr horizon has hue of 10YR, 2.5Y, or 5BG or is neutral in hue. It has value of 4 to 6 when moist and 6 to 8 when dry and chroma of 0 to 3. It is mottled in most places. It is dense, compact glacial till that crushes to the gravelly, very gravelly, or extremely gravelly analogs of sandy loam, loam, clay loam, silty clay loam, or silty clay.

Melbourne Series

The Melbourne series consists of deep, well drained soils on uplands. These soils formed in siltstone and shale residuum. Slope is 5 to 65 percent. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 60 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine, mixed, mesic Ultic Haploxeralfs.

Typical pedon of Melbourne silty clay loam, 5 to 20 percent slopes, 3 miles south of Rochester; about 1,450 feet west and 1,900 feet south of the northeast corner of sec. 17, T. 15 N., R. 3 W.

A1-0 to 6 inches; dark brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure;, hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

A2-6 to 11 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; few very fine tubular pores; slightly acid; clear smooth boundary.

Bt1-11 to 21 inches; dark brown (7.5YR 3/4) silty clay loam, brown (10YR 4/3) dry; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine interstitial pores and common very fine tubular pores; common thin clay films on faces of peds and lining pores; medium acid; gradual smooth boundary.

Bt2-21 to 42 inches; dark brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) dry; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; many thin and moderately thick clay films on faces of peds and lining pores; very strongly acid; gradual smooth boundary.

Bt3-42 to 54 inches; dark brown (7.5YR 3/4) silty clay loam, dark brown (7.5YR 4/4) dry; strong medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; common thin and moderately thick clay films on faces of peds and lining pores; very strongly acid; gradual smooth boundary.

BCt-54 to 60 inches; dark brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; moderate medium and coarse subangular blocky structure; hard, friable, sticky and slightly plastic; few very fine tubular pores; few thin and moderately thick clay films on faces of peds and lining pores; 20 percent fragments of soft siltstone; very strongly acid.

The solum ranges from 40 to more than 60 inches in thickness. The soil has hue of 10YR or 7.5YR throughout. Base saturation, by sum of cations, is 35 to 70 percent in the upper 30 inches of the argillic horizon. The control section is silty clay loam, silty clay, clay loam, or clay. The content of clay in this section ranges from 35 to 60 percent.

The A horizon has value of 2 or 3 when moist and 4 to 6 when dry and chroma of 2 to 4 when moist or dry. It is slightly acid or medium acid. The Bt horizon has value of 3 to 5 when moist and 4 to 6 when dry and chroma of 3 or 4 when moist and 3 to 8 when dry. It is silty clay loam, silty clay, or clay. It is medium acid to very strongly acid. Some pedons have a C horizon. This horizon has value of 4 or 5 when moist and 5 or 6 when dry and chroma of 2 to 4 when moist and 2 to 8 when dry. It is clay loam, silty clay loam, silty clay, or clay. It is strongly acid or very strongly acid.

Mukilteo Series

The Mukilteo series consists of very deep, very poorly drained soils in upland depressions. These soils formed in deep organic deposits. Slope is 0 to 2 percent. Elevation is 50 to 700 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are dystic. mesic Typic Medihemists.

Typical pedon of Mukilteo muck, drained, 3 miles northeast of Olympia; about 600 feet north and 500 feet west of the southeast corner of sec. 12, T. 18 N., R. 2 W.

Oe-0 to 2 inches; dark yellowish brown (10YR 4/4) sapric material; about 20 percent fiber, 10 percent rubbed; about 70 percent fine fibrous roots; extremely acid; abrupt smooth boundary.

Oa-2 to 6 inches; dark reddish brown (5YR 2/2) sapric material; about 50 percent fiber, 6 percent rubbed; moderate fine angular blocky structure; friable; many fine roots; very strongly acid; abrupt smooth boundary.

O'e1-6 to 11 inches; dark reddish brown (5YR 3/2) hemic material; about 80 percent fiber, 20 percent rubbed; weak fine subangular blocky structure; friable; common fine roots; very strongly acid; clear smooth boundary.

O'e2-11 to 42 inches; dark reddish brown (5YR 3/2) hemic material; about 65 percent fiber, 20 percent rubbed; massive; friable; few fine roots to a depth of about 24 inches; very strongly acid; clear smooth boundary.

O'e3-42 to 72 inches; dark reddish brown (5YR 3/2) heroic material; about 60 percent fiber, 24 percent rubbed; massive; friable; very strongly acid.

The organic material ranges from 52 to more than 120 inches in thickness. The soils are strongly acid or very strongly acid. The fibers are derived mostly from sedges.

The surface tier has hue of 5YR or 7.5YR. value of 2 or 3, and chroma of 1 or 2. It generally has one or more layers of sapric material that is less than 15 percent fiber when rubbed. The subsurface tiers are hemic. They have hue of 5YR or 10YR and value and chroma of 2 to 4. The content of fiber in these tiers ranges from 18 to 50 percent after rubbing. The bottom tier is similar in color and fiber content to the subsurface tiers, but it generally has a higher fiber content.

Newberg Series

The Newberg series consists of very deep, well drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 100 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 165 to 210 days.

These soils are coarse-loamy, mixed, mesic Fluventic Haploxerolls.

Typical pedon of Newberg loam, 5 miles southeast of Rochester; about 1,875 feet north and 250 feet east of the southwest corner of sec. 24, T. 15 N., R. 3 W.

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many microinterstitial pores; slightly acid; abrupt smooth boundary.

A-8 to 17 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak coarse and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine tubular pores and many micro interstitial pores; slightly acid; abrupt smooth boundary.

C1-17 to 42 inches; dark yellowish brown (10YR 3/4) fine sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine tubular pores; slightly acid; abrupt smooth boundary.

C2-42 to 60 inches; dark yellowish brown (10YR 3/4) fine sandy loam, light brownish gray (10YR 6/2) dry; single grained; loose, very friable. nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; slightly acid.

The mollic epipedon is 10 to 15 inches thick. Reaction ranges from slightly acid to medium acid throughout the profile. The control section averages loamy very fine sand or sandy loam and lacks contrasting textures.

The upper 10 inches of the A horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 2 or 3. The lower part has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4. In some areas very gravelly or sandy substrata are below a depth of 40 inches.

Nisqually Series

The Nisqually series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in sandy glacial outwash. Slope is 0 to 15 percent. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are sandy; mixed, mesic Pachic Xerumbrepts.

Typical pedon of Nisqually loamy fine sand. 0 to 3 percent slopes, 5 miles south of Olympia; about 700 feet east and 350 feet south of the northwest corner of sec. 13.T. 17N., R. 2W.

Ap-0 to 5 inches; black (5YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; massive; soft, very friable, nonsticky and nonplastic; many medium and fine roots; very high organic matter content; medium acid; abrupt smooth boundary.

A1-5 to 18 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; massive; soft, very friable, nonsticky and nonplastic; common medium and fine roots, high organic matter content; medium acid; gradual wavy boundary.

A2-18 to 31 inches; very dark grayish brown (10YR 3/2) loamy fine sand. grayish brown (10YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; common medium and fine roots; medium acid; gradual wavy boundary.

C1-31 to 48 inches; light olive brown (2.5Y 5/4) loamy sand, grayish brown (2.5Y 5/2) dry; massive; soft, very friable. nonsticky and nonplastic; common medium and fine roots; slightly acid; gradual wavy boundary.

C2-48 to 60 inches; light olive brown (2.5Y 5/4) loamy sand, light brownish gray (2.5Y 6/2) dry; single grained; loose; few medium and fine roots; slightly acid.

The umbric epipedon is 25 to 38 inches thick. The soils are slightly acid or medium acid throughout.

The A horizon has hue of 5YR to 10YR, value of 2 or 3 when moist and 2 to 4 when dry, and chroma of 1 or 2 when moist or dry. The part of this horizon below the surface layer is loamy fine sand or loamy sand.

Norma Series

The Norma series consists of very deep, poorly drained soils in depressions on till plains. These soils formed in old alluvium. Slope is 0 to 3 percent. Elevation is 50 to 500 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are coarse-loamy, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Norma silt loam, 4 miles southwest of Tumwater; about 650 feet west and 1,000 feet north of the southeast corner of sec. 21, T. 17 N., R. 2 W.

Ap-0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

Bw-8 to 30 inches; grayish brown (2.5Y 5/2) sandy loam, light brownish gray (2.5Y 6/2) dry; common medium prominent reddish yellow (7.5YR 6/6) mottles; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots;; many very fine tubular pores; medium acid; clear smooth boundary.

Cg-30 to 60 inches; olive gray (5Y 5/2) sandy loam, light gray (5Y 7/2) dry; common medium prominent red (2.5YR 5/8) mottles; massive; soft, very friable, nonsticky and nonplastic; few fine roots; many very fine tubular pores; slightly acid.

The control section is 0 to 20 percent coarse fragments, 5 to 10 percent clay, and more than 15 percent fine sand or coarser sand.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 to 3 when moist or dry. It ranges from strongly acid to slightly acid. The B horizon has hue of 10YR to 5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry. It is fine sandy loam, loam, sandy loam, or silt loam. It is medium acid or slightly acid. The C horizon has hue of 2.5Y or 5Y. It is sandy loam or loamy sand. It is medium acid or slightly acid.

Olympic Series

The Olympic series consists of very deep, well drained soils on uplands. These soils formed in material weathered from basalt. Slope is 5 to 40 percent. Elevation is 200 to 1,600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are clayey, mixed, mesic Xeric Haplohumults.

Typical pedon of Olympic silt loam, 20 to 40 percent slopes, 4 miles west of Littlerock; about 1,000 feet west and 2,400 feet south of the northeast corner of sec. 6, T. 16 N., R. 3 W.

A1-0 to 6 inches; dark brown (7.5YR 3/2) silt loam, dark brown (10YR 4/3) dry; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and plastic; many fine and medium

roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

A2-6 to 12 inches, dark reddish brown (5YR 3/3) silt loam, dark yellowish brown (10YR 4/4) dry; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and plastic; many fine and medium roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

Bt1-12 to 24 inches; yellowish red (5YR 4/6) silty clay loam. dark brown (7.5YR 4/4) dry; moderate very fine and fine subangular blocky structure; hard, friable, slightly sticky and plastic; common very fine and fine roots; many very fine tubular pores; common thin clay films on faces of peds and lining pores; medium acid; gradual smooth boundary.

Bt2-24 to 35 inches; yellowish red (5YR 4/6) clay, reddish brown (5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and very plastic; common fine roots; common very fine and fine tubular pores; common thin clay films on faces of peds and lining pores; very strongly acid; gradual smooth boundary.

Bt3-35 to 60 inches; yellowish red (5YR 4/6) clay, yellowish red (5YR 5/6) dry; moderate fine, medium, and coarse subangular blocky structure; hard, friable, slightly sticky and very plastic; few fine roots, common very fine and fine tubular pores; many thin and continuous moderately thick clay films on faces of peds and lining pores; very strongly acid.

The solum ranges from 40 to more than 60 inches in thickness. It has hue of 7.5YR or 5YR throughout. It ranges from slightly acid to very strongly acid.

The A horizon has value of 3 or 4 when moist and 4 or 5 when dry and chroma of 2 or 3 when moist and 3 or 4 when dry. The B horizon has value of 3 or 4 when moist and 4 or 5 when dry and chroma of 4 to 6 when moist or dry. It is clay loam, silty clay loam, silty clay, or clay. The content of rock fragments below a depth of 40 inches ranges from 0 to about 45 percent.

Pheeney Series

The Pheeney series consists of moderately deep, well drained soils on upland ridgetops and mountain slopes. These soils formed in residuum and colluvium derived from andesite mixed with volcanic ash. Slope is 5 to 90 percent. Elevation is 1,500 to 2,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 130 to 170 days.

These soils are medial-skeletal, frigid Andic Xerumbrepts.

Typical pedon of Pheeney gravelly loam, 5 to 30 percent slopes, 3 miles south of Vail; about 1,750 feet east and 2,375 feet south of the northwest corner of sec. 3. T. 15 N., R. 1 E.

Oi-0.5 inch to 0; loose, undecomposed forest litter and moss.

A1-0 to 6 inches; black (10YR 2/1) gravelly loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; 20 percent angular pebbles; medium acid; clear broken boundary.

A2-6 to 10 inches; very dark brown (10YR 2/2) gravelly silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots; many fine pores; 30 percent angular pebbles; medium acid; clear broken boundary.

Bw-10 to 30 inches; dark yellowish brown (10YR 3/4) very gravelly silt loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; 45 percent angular pebbles; 20 percent cobbles; medium acid; abrupt irregular boundary.

R-30 inches; slightly weathered, fractured andesite.

The depth to lithic contact ranges from 20 to 40 inches. The content of rock fragments in the particle-size control section ranges from 35 to 65 percent. The soils are strongly acid or medium acid throughout.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 to 3 when moist or dry. The content of pebbles in this horizon is 15 to 30 percent. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. It is very gravelly silt loam or very gravelly loam. The content of pebbles in this horizon is 25 to 50 percent, and the content of cobbles is 10 to 20 percent.

Pilchuck Series

The Pilchuck series consists of deep, somewhat excessively drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 600 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about

50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are mixed. mesic Dystic Xeropsamments.

Typical pedon of Pilchuck loamy sand, 6 miles east of Lacey; about 400 feet east and 900 feet north of the southwest corner of sec. 9. T. 18 N., R. 1 E.

A-0 to 6 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (2.5Y 4/2) dry; single grained; loose; few fine and medium roots; many very fine interstitial pores; neutral; abrupt wavy boundary.

C1-6 to 24 inches; very dark grayish brown (10YR 3/2) fine sand, gray (10YR 5/1) dry; single grained; loose; few fine and medium roots; many very fine interstitial pores; neutral; abrupt wavy boundary.

C2-24 to 32 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; single grained; loose; few fine roots; many very fine interstitial pores; neutral; abrupt wavy boundary.

C3-32 to 60 inches; dark gray (10YR 4/1) fine sand, grayish brown (10YR 5/2) dry; single grained; loose; few fine roots; many very fine interstitial pores; neutral.

The control section is sand, fine sand, or loamy fine sand. The content of coarse fragments in this section ranges from 0 to 15 percent by weighted average. The soils are neutral or slightly acid throughout. In some areas, the A horizon has weak granular structure and the part of the profile below the A horizon is structureless. In other areas the soil is structureless throughout. The upper 40 inches has hue of 10YR or 2.5Y, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. It is loamy sand. loamy fine sand, fine sand, or sand. The part of the profile below the control section has colors and textures similar to those in the upper 40 inches, but the range includes gravelly analogs.

Prather Series

The Prather series consists of very deep, moderately well drained soils on terraces. These soils formed in highly weathered, ancient glacial drift. Slope is 3 to 20 percent. Elevation is 200 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are clayey, kaolinitic, mesic Xeric Haplohumults.

Typical pedon of Prather silty clay loam, 3 to 8 percent slopes, 4 miles southeast of Rochester; about 2,400 feet west and 1.150 feet north of the southeast corner of sec. 21, T. 15 N., R. 3 W.

A1-0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; moderate very fine and fine subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine, fine, and medium roots; few very fine and fine tubular pores and many very fine interstitial pores; medium acid; clear smooth boundary.

A2-5 to 12 inches; dark brown (7.5YR 3/4) silty clay loam, pale brown (10YR 6/3) dry; moderate very fine, fine, and medium subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine and fine roots; common very fine tubular pores and many very fine interstitial pores; medium acid; clear smooth boundary.

Bt1-12 to 29 inches; dark brown (7.5YR 4/4) silty clay, strong brown (7.5YR 5/6) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; common very fine tubular pores; common thin clay films on faces of peds and lining pores; strongly acid; gradual smooth boundary.

Bt2-29 to 42 inches; dark brown (7.5YR 4/4) silty clay, strong brown (7.5YR 5/6) dry; common medium faint brown (7.5YR 5/2) mottles; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; common very fine tubular pores; many thin clay films on faces of peds and lining pores; strongly acid; clear irregular boundary.

BCt-42 to 60 inches; yellowish brown (10YR 5/6) clay, strong brown (7.5YR 5/6) dry; common medium distinct gray (10YR 5/1) mottles; moderate medium and coarse subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores; many thin and moderately thick clay films on faces of peds and lining pores; medium acid.

The solum ranges from 40 to more than 60 inches in thickness, The depth to slowly permeable or very slowly permeable material ranges from 20 to 30 inches. The depth to mottles that have chroma of 2 or less also ranges from 20 to 30 inches. The particle-size control section is 35 to 65 percent clay. It typically is silty clay, but in some areas it is silty clay loam or clay. Some pedons have a C horizon. Hue is 10YR or 7.5YR in the A horizon and in the upper part of the B horizon and ranges from 2.5YR to 2.5Y in the BC and C horizons.

The A horizon has value of 2 or 3 when moist and 5 or 6 when dry and chroma of 2 to 4 when moist or dry. It is slightly acid or medium acid. The Bt horizon has value of 3 to 5 when moist and 4 or 5 when dry and chroma of 4 to 6 when moist and 6 to 8 when dry. It is silty clay or clay. It is medium acid or strongly acid.

Puget Series

The Puget series consists of very deep.. poorly drained soils in depressions on flood plains. Drainage has been altered by tiling. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 10 to 100 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

The soils are fine-silty, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Puget silt loam, 5 miles east of Lacey; about 1,800 feet west and 1,450 feet south of the northeast corner of sec. 18, T. 18 N., R. I E.

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine prominent yellowish red (5YR 4/8) mottles; moderate fine and medium granular structure; hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; slightly acid; abrupt smooth boundary.

A-6 to 9 inches; very dark grayish brown (10YR 3/2) silt loam. light brownish gray (10YR 6/2) dry; common fine prominent yellowish red (5YR 5/8) mottles; moderate coarse and very coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; common very fine tubular pores; slightly acid; abrupt smooth boundary.

Cg1-9 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many medium prominent yellowish red (5YR 4/8) mottles; moderate medium and coarse subangular blocky structure; hard. friable, sticky and slightly plastic; common very fine and fine roots; common very fine and many medium and coarse tubular pores; slightly acid; gradual smooth boundary.

Cg2-30 to 36 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; many medium prominent yellowish red (5YR 4/8) mottles; weak coarse and very coarse subangular blocky structure, slightly hard, very friable, slightly sticky and nonplastic; few very fine and fine roots; many medium and coarse pores; slightly acid; gradual wavy boundary.

Cg3-36 to 60 inches; olive gray (5Y 4/2) silt loam, light olive gray (5Y 6/2) dry; common fine prominent yellowish brown (10YR 5/8) mottles; massive; slightly hard, very friable, slightly sticky and nonplastic; medium acid.

The A horizon has value of 3 to 5 when moist and 5 or 6 when dry and chroma of 1 or 2 when moist or dry. It is medium acid to neutral. The Cg horizon is slightly acid to very strongly acid. The part of this horizon within a depth of 40 inches has hue of 10YR to 5Y and value of 4 or 5 when moist and 6 or 7 when dry. It is dominantly silt loam or silty clay loam, but some pedons have strata of sand or loamy sand. These strata are less than 2 inches thick. The part of the Cg horizon below a depth of 40 inches has hue of 2.5Y, 5Y, or 5GY, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 0 to 2 when moist or dry. It is dominantly silt loam, silty clay loam, or silty clay, but in some pedons it has strata of sand or loamy sand.

Puyallup Series

The Puyallup series consists of deep, well drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 200 days.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haploxerolls.

Typical pedon of Puyallup silt loam, 2 miles southeast of Tumwater; about 1,100 feet west and 2,400 feet south of the northeast corner of sec. 1 , T. 17 N., R. 2 W.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; slightly acid; abrupt wavy boundary.

A1-10 to 12 inches; dark brown (10YR 3/3) loamy fine sand, dark grayish brown (10YR 4/2) dry; massive; loose. very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; neutral; abrupt wavy boundary.

A2-12 to 19 inches; dark brown (10YR 3/3) fine sandy

loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; neutral; abrupt wavy boundary.

2C-19 to 60 inches; very dark gray (10YR 3/1) sand, dark grayish brown (10YR 4/2) dry; single grained; loose; neutral.

The upper part of the particle-size control section is fine sandy loam, loam, or silt loam. The content of clay in this part of the control section is 5 to 15 percent. The soils are neutral to medium acid throughout.

The A horizon has hue of 10YR or 2.5Y and value and chroma of 2 or 3. It is silt loam. fine sandy loam, or loamy fine sand. Depth to the 2C horizon ranges from 15 to 20 inches. This horizon has value of 3 to 5 when moist and 4 to 6 when dry. It is sand, loamy sand, or gravelly sand. The content of pebbles in this horizon ranges from 0 to 20 percent.

Rainier Series

The Rainier series consists of deep, moderately well drained soils on mountain slopes. These soils formed in material weathered from breccia and glacial till. Slope is 5 to 65 percent. Elevation is 700 to 1,700 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 150 days.

These soils are fine, mixed, mesic Ultic Haploxeralfs.

Typical pedon of Rainier clay loam, 5 to 30 percent slopes. 16 miles east of Vail; about 1,500 feet west and 400 feet south of the northeast corner of sec. 11 T. 15 N.. R. 3 E.

Oi-1 inch to 0; needles, twigs, bark, and moss.

A1-0 to 2 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots; medium acid; abrupt smooth boundary.

A2-2 to 8 inches; very dark grayish brown (10YR 3/2) clay loam. grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many roots; medium acid; clear wavy boundary.

AB-8 to 14 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; common roots; medium acid; clear wavy boundary.

Bt1-14 to 21 inches; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate medium and coarse subangular blocky structure; hard, firm, sticky and plastic; few roots; strongly acid; gradual wavy boundary.

Bt2-21 to 32 inches; dark brown (7.5YR 3/2) clay, brown (7.5YR 5/4) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, very firm, very sticky and very plastic; common fine and medium roots that tend to fan out at the bottom of the horizon; thin nearly continuous clay films on faces of peels; strongly acid; gradual wavy boundary.

Bt3-32 to 45 inches; dark brown (7.5YR 3/2) clay, brown (7.5YR 4/4) dry; moderate coarse and very coarse subangular blocky structure; extremely hard, very firm, sticky and plastic; strongly acid; gradual irregular boundary.

R-45 inches; massive, slightly weathered breccia; few fractures more than 4 inches apart.

The depth to hard breccia ranges from 40 to 60 inches. The content of rock fragments in the control section ranges from 0 to 30 percent. The content of clay ranges from 35 to 45 percent.

The A horizon has hue of 10YR or 7.5YR. It is strongly acid or medium acid. The AB horizon is clay loam or loam. The Bt horizon has hue of 10YR to 5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry. It is very strongly acid or strongly acid. It is clay, silty clay loam, or silty clay. The content of rock fragments in this horizon ranges from 0 to 15 percent.

Raught Series

The Raught series consists of very deep, well drained soils on uplands. These soils formed in material weathered from basalt. Slope is 5 to 65 percent. Elevation is 200 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial, mesic Andic Xerumbrepts.

Typical pedon of Raught silt loam, 5 to 30 percent slopes, 12 miles west of Olympia; about 150 feet east and 1,800 feet north of the southwest corner of sec. 24, T. 18 N., R. 4 W.

A-0 to 11 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) dry; strong fine, medium, and

coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine tubular pores; slightly acid; gradual wavy boundary.

Bw1-11 to 30 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; strong fine, medium, and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common fine and medium tubular pores; slightly acid; clear smooth boundary.

Bw2-30 to 55 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; strong medium, coarse, and very coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few coarse roots; few very fine tubular pores; 10 percent angular pebbles; slightly acid; clear smooth boundary.

Bw3-55 to 60 inches; dark reddish brown (5YR 3/4) silt loam, strong brown (7.5YR 5/6) dry; strong medium, coarse, and very coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few coarse roots; few very fine tubular pores; 10 percent angular pebbles; medium acid.

The particle-size control section ranges from 5 to 15 percent rock fragments. The depth to basalt is more than 60 inches.

The A horizon has value of 4 or 5 when dry and chroma of 2 or 3 when moist or dry. The Bw horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist, and chroma of 3 or 4 when moist and 3 to 6 when dry. It is silt loam or silty clay loam. The content of pebbles in this horizon is as much as 15 percent.

Salkum Series

The Salkum series consists of deep, well drained soils on terraces. These soils formed in highly weathered, ancient glacial drift. Slope is 3 to 30 percent. Elevation is 200 to 600 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are clayey, kaolinitic, mesic Xeric Haplohumults.

Typical pedon of Salkum silty clay loam, 8 to 15 percent slopes, 2 miles southwest of Rochester; about 800 feet east and 2,300 feet south of the northwest corner of sec. 7, T. 15 N., R. 3 W.

A-0 to 6 inches; dark brown (7.5YR 3/4) silty clay loam, yellowish brown (10YR 5/4) dry; strong very fine, fine, and medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; common very fine tubular pores; very strongly acid; clear smooth boundary.

AB-6 to 12 inches; dark brown (7.5YR 4/4) silty clay loam, pale brown (10YR 6/3) dry; strong very fine, fine, and medium subangular blocky structure; hard, very friable, sticky and slightly plastic; many very fine, fine, and medium roots; common very fine tubular pores; few thin clay films on faces of peds and lining pores; very strongly acid; clear smooth boundary.

Bt1-12 to 39 inches; reddish brown (5YR 4/4) silty clay, reddish yellow (7.5YR 6/8) dry; strong medium and coarse subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; very strongly acid; gradual smooth boundary.

Bt2-39 to 51 inches; yellowish red (5YR 4/6) silty clay, strong brown (7.5YR 5/6) dry; moderate fine, medium, and coarse subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; very strongly acid; clear wavy boundary.

BC-51 to 60 inches; yellowish red (5YR 5/8) silty clay, yellow (10YR 8/6) dry; weak fine, medium, and coarse subangular blocky structure; hard, friable, sticky and plastic; many very fine tubular pores; common thick clay films on faces of peds and lining pores; very strongly acid.

The soils are medium acid to very strongly acid throughout. 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. The Bt horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It is silty clay loam or silty clay in which the content of clay is 40 to 55 percent. The depth to mottles that have chroma of 2 or less is more than 36 inches.

Scamman Series

The Scamman series consists of deep, somewhat poorly drained soils on terraces. These soils formed in mixed glacial and sedimentary material. Slope is 0 to 20 percent. Elevation is 150 to 1,600 feet. The average annual precipitation is 45 to 70 inches, the average

annual air temperature is 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine, mixed, mesic Aquic Palexeralfs.

Typical pedon of Scamman silty clay loam, 5 to 20 percent slopes. 16 miles southeast of Yelm; about 1,700 feet west and 1,900 feet north of the southeast corner of sec. 17, T. 15 N., R. 4 E.

A-0 to 5 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate very fine and fine subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; common very fine and fine roots; many very fine interstitial pores; slightly acid; abrupt smooth boundary.

E-5 to 11 inches; dark yellowish brown (10YR 4/4) silty clay loam, very pale brown (10YR 7/3) dry; common fine prominent grayish brown (2.5Y 5/2) mottles; moderate medium and coarse subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B/E-11 to 24 inches; about 35 percent gray (10YR 5/1) silt loam (E), white (10YR 8/2) dry, on faces of peds and in pores, 1 to 3 millimeters thick; massive; about 65 percent dark brown (10YR 4/3) peds of silty clay loam (B), very pale brown (10YR 7/3) dry; common medium distinct strong brown (7.5YR 5/6) mottles; moderate fine,, medium, and coarse subangular blocky structure; hard, friable, very sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; common thin clay films on faces of peds and lining pores; medium acid; clear smooth boundary.

Bt1-24 to 34 inches; dark grayish brown (10YR 4/2) silty clay, light gray (10YR 7/2) dry; many large prominent strong brown (7.5YR 5/6) mottles; weak medium and coarse prismatic structure; hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; common thin and moderately thick clay films on faces of peds and lining pores; medium acid; abrupt smooth boundary.

Bt2-34 to 60 inches; dark grayish brown (10YR 4/2) silty clay, white (10YR 8/2) dry; many large prominent yellowish red (5YR 4/6) mottles; strong coarse and very coarse angular blocky structure; very hard, firm, sticky and plastic; medium acid.

The thickness of the solum ranges from 48 to more than 60 inches. The control section is silty clay or clay in which the content of clay is 42 to 60 percent. The content of rock fragments is less than 5 percent throughout the profile.

The A or Ap horizon has value of 2 to 4 when moist and 4 or 5 when dry and chroma of 2 or 3 when moist or dry. It is neutral or slightly acid. The E horizon has value of 4 or 5 when moist and 5 to 7 when dry and chroma of 3 or 4 when moist or dry. The B part of the B/E horizon has value of 4 or 5 when moist and 5 to 7 when dry and chroma of 3 or 4 when moist or dry. It is silty clay loam or silty clay and makes up 55 to 65 percent of the horizon. The E part has value of 4 or 5 when moist and 7 or 8 when dry and chroma of 1 or 2 when moist or dry. It makes up 30 to 45 percent of the horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 1 to 3 when moist and 2 or 3 when dry. It has thin to thick clay films on faces of peds and lining pores.

Schneider Series

The Schneider series consists of deep, well drained soils on foothills and mountains. These soils formed in colluvium derived from basalt. Slope is 20 to 65 percent. Elevation is 500 to 1,200 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial-skeletal, mesic Andic Xerumbrepts.

Typical pedon of Schneider very gravelly loam, 20 to 40 percent slopes, 7 miles northwest of Olympia; about 2,100 feet east and 2,300 feet north of the southwest corner of sec. 2, T. 18 N., R. 3 W.

A-0 to 6 inches; dark brown (7.5YR 3/2) very gravelly loam, dark brown (7.5YR 4/2) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many very fine interstitial pores; 55 percent angular basalt pebbles; slightly acid; clear smooth boundary.

AB-6 to 22 inches; dark reddish brown (5YR 3/3) very gravelly silt loam, dark brown (7.5YR 4/4) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many medium and coarse roots; many very fine interstitial pores; 60 percent angular basalt pebbles; medium acid; clear smooth boundary.

Bw1-22 to 32 inches; dark reddish brown (5YR 3/3) very gravelly silt loam, dark brown (7.5YR 4/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; common very fine tubular pores; 55 percent angular

basalt pebbles; medium acid; gradual wavy boundary.

Bw2-32 to 55 inches; dark brown (7.5YR 4/4) extremely gravelly silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; common very fine tubular pores; 80 percent angular basalt pebbles; medium acid; abrupt wavy boundary.

R-55 inches; fractured basalt.

The depth to fractured basalt ranges from 40 to more than 60 inches. The content of rock fragments in the 10- and 40-inch control section ranges from 35 to 80 percent. The fragments are dominantly angular basalt pebbles. Pedons at elevations of less than 800 feet also have rounded pebbles. The particle-size control section is dominantly amorphous material.

The A horizon has hue of 7.5YR or 10YR when moist, value of 2 or 3 when moist and 3 to 5 when dry. and chroma of 2 or 3 when moist. It is slightly acid to strongly acid. The AB horizon has hue of 5YR or 7.5YR. value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 3 or 4 when dry. It is slightly acid to strongly acid. The Bw horizon has hue of 5YR to 10YR. value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and dry. It is slightly acid or medium acid. The AB and Bw horizons are the very gravelly or extremely gravelly analogs of loam or silt loam. Some pedons have a C horizon.

Semiahmoo Series

The Semiahmoo series consists of very deep, very poorly drained soils on flood plains. Drainage has been altered by tiling and open ditches. These soils formed in herbaceous organic deposits. Slope is 0 to 3 percent. Elevation is 20 to 300 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average annual frost-free season is 150 to 200 days.

These soils are euic, mesic Typic Medisaprists.

Typical pedon of Semiahmoo muck, 2 miles north of Littlerock; about 850 feet east and 1,575 feet north of the southwest corner of sec. 25, T. 17 N., R. 3 W.

Op-0 to 6 inches; black (5YR 2/1) sapric material, very dark gray (5YR 3/1) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; 15 percent fiber, 5 percent rubbed; few medium and common very fine and fine roots; common very fine tubular pores; medium acid; clear wavy boundary.

Oa1-6 to 25 inches; black (5YR 2/1) sapric material, dark reddish brown (5YR 2/2) dry; weak very thin platy structure; hard, very friable, nonsticky and nonplastic; 30 percent fiber, 10 percent rubbed; few very fine and fine roots; few medium and common very fine tubular pores; medium acid; abrupt smooth boundary.

Oa2-25 to 60 inches; black (5YR 2/1) sapric material, dark reddish brown (5YR 2/2) dry; massive; hard, very friable, nonsticky and nonplastic; 25 percent fiber, 15 percent rubbed; few very fine roots; few medium and fine tubular pores; medium acid.

The organic material is more than 60 inches thick. It is mostly grass and sedge material, but in some areas it includes as much as 5 percent woody material. The control section is dominantly sapric material. The fiber content ranges from 20 to 40 percent, 5 to 15 percent rubbed. The bottom tier generally has the highest fiber content. When moist, the tiers have hue of 5YR or 7.5YR and value and chroma of 1 or 2. The soils are very strongly acid to medium acid throughout. Some pedons have a 2C horizon, which is sand to clay.

Shalcar Series

The Shalcar series consists of deep, very poorly drained soils in upland depressions. These soils formed in organic deposits over alluvium. Slope is 0 to 2 percent. Elevation is 50 to 700 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are loamy, mixed. euic, mesic Terric Medisaprists.

Typical pedon of Shalcar muck, 2 miles southwest of Yelm; about 1,800 feet east and 2,000 feet south of the northwest corner of sec. 36, T. 17 N., R. 1 E.

Op-0 to 6 inches; black (5YR 2/1) sapric material, very dark brown (10YR 2/2) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; about 20 percent fiber, 10 percent rubbed; about 60 percent live fine fibrous roots; very strongly acid; clear smooth boundary.

Oa-6 to 24 inches; black (5YR 2/1) sapric material, dark reddish brown (5YR 2/2) dry; moderate fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; about 40 percent fiber, 10 percent rubbed; common fine roots; very

strongly acid; abrupt smooth boundary.

C1-24 to 29 inches; olive gray (5Y 5/2) silt loam, light gray (5Y 7/1) dry; moderate medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few fine and medium tubular pores; medium acid; gradual wavy boundary.

C2-29 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, white (5Y 8/2) dry; common medium prominent brown (7.5YR 5/4) mottles; massive; hard, very friable, sticky and plastic; few fine pores; medium acid.

The organic material ranges from 20 to 30 inches in thickness. It is mostly grass and sedge material. The content of fiber ranges from 20 to 40 percent, 5 to 15 percent rubbed. The tiers have hue of 5YR to 10YR when moist and value and chroma of 1 or 2 when moist and 2 or 3 when dry. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist or dry. It is silt loam to silty clay loam.

Shalcar Variant

The Shalcar Variant consists of deep, very poorly drained soils on flood plains. These soils formed in organic deposits over alluvium. Slope is 0 to 3 percent. Elevation is 20 to 300 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are clayey, mixed,, euic, mesic Terric Medisaprists.

Typical pedon of Shalcar Variant muck, 1 mile southeast of Vail; about 1,325 feet west and 800 feet north of the southeast corner of sec. 35. T. 16 N., R. 1 E.

Op-0 to 6 inches; dark reddish brown (5YR 2/2) sapric material. dark reddish brown (2.5YR 2/4) dry; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; 15 percent fiber, 5 percent rubbed; few medium and common very fine and fine roots; common very fine tubular pores; medium acid; clear smooth boundary.

Oa-6 to 20 inches; black (5YR 2/1) sapric material, dark reddish brown (5YR 3/2) dry; moderate medium subangular blocky structure; hard, very friable, nonsticky and nonplastic; 30 percent fiber, 10 percent rubbed; few very fine and fine roots; common very fine tubular pores; strongly acid; abrupt smooth boundary.

C1-20 to 25 inches; very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) silty clay, dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) dry; strong very thin platy structure; hard, very friable, sticky and plastic; few very fine and fine roots; few fine and medium tubular pores; medium acid; gradual wavy boundary.

C2-25 to 60 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) clay, very dark grayish brown (2.5Y 3/2) and grayish brown (2.5Y 5/2) dry; moderate very thin and thin platy structure; hard, very friable, sticky and plastic; few fine pores; medium acid.

The organic material ranges from 16 to 30 inches in thickness. The fiber content ranges from 20 to 50 percent, 5 to 15 percent rubbed. The tiers have hue of 2.5YR to 7.5YR when moist and value and chroma of 1 or 2 when moist and 2 to 4 when dry. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 3 to 6 when dry, and chroma of 2 when moist or dry. It is silty clay to clay and is strongly acid or medium acid.

Skipopa Series

The Skipopa series consists of moderately deep, somewhat poorly drained soils on terraces. These soils formed in volcanic ash and loess over glaciolacustrine sediment. Slope is 0 to 15 percent. Elevation is 150 to 300 feet. The average annual precipitation is 40 to 50 inches, the average annual temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial over clayey, mixed, mesic Aquic Xerochrepts.

Typical pedon of Skipopa silt loam, 0 to 3 percent slopes, 8 miles northwest of Olympia; about 2,600 feet east and 1,100 feet north of the southwest corner of sec. 27, T. 19 N., R. 3 W.

Apc-0 to 8 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; strong fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine roots; very porous; 25 to 50 percent iron concretions; medium acid; abrupt smooth boundary.

Bt-8 to 15 inches; brown (10YR 4/3) silt loam, pale yellow (2.5Y 7/4) dry; strong fine angular blocky

structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine roots; very porous; 10 percent concretions; thin patchy clay films on faces of peds and in pores; medium acid; clear wavy boundary.

2Btg-15 to 18 inches; grayish brown (2.5Y 5/2) silty clay loam. light gray (2.5Y 7/2) dry; many medium faint dark yellowish brown (10YR 4/4) mottles; strong fine angular blocky structure; hard, friable, sticky and plastic; common fine roots; common medium and fine tubular pores and fine interstitial pores; thin continuous clay films on faces of peds and in pores; medium acid; clear wavy boundary.

2Cg1-18 to 28 inches; greenish gray (5GY 6/1) silty clay. pale yellow (5Y 7/3) dry; common medium distinct strong brown (7.5YR 5/8) mottles; moderate fine prismatic structure parting to moderate thin platy; hard, firm, very sticky and very plastic; few fine roots; common fine tubular pores and many medium interstitial pores; medium continuous clay films on peds and in pores; medium acid; gradual wavy boundary.

2Cg2-28 to 60 inches; greenish gray (5GY 6/1) clay, light gray (5Y 7/1) dry; common medium distinct strong brown (7.5YR 5/8) mottles; massive; thin platy laminations; hard, very firm, very sticky and very plastic; common medium interstitial pores; medium acid.

The thickness of the solum ranges from 14 to 24 inches. The content of rock fragments in the control section ranges from 0 to 10 percent.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist and dry. It is medium acid or slightly acid. The Bt horizon has hue of 10YR or 2.5Y, 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 in which the content of clay ranges from 12 to 30 percent. It is medium acid or strongly acid. The 2C horizon has hue of 2.5Y, 5Y, 5G, or 5GY, value of 4 to 6 when moist and 7 or 8 when dry, chroma of 1 to 3 when moist or dry. It is silty clay or clay in which the content of clay ranges from 40 to 60 percent. This horizon is slightly acid or medium acid.

Spana Series

The Spana series consists of very deep, somewhat poorly drained soils in drainageways on outwash plains. These soils formed in glacial outwash. Slope is 0 to 3 percent. Elevation is 100 to 500 feet. The average annual precipitation is 35 to 45 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are loamy-skeletal, mixed, mesic Pachic Xerumbrepts.

Typical pedon of Spana gravelly loam, 4 miles southeast of Lacey; about 2,300 feet west and 400 feet north of the southeast corner of sec. 25. T. 18 N., R. 1 W.

A-0 to 22 inches; black (10YR 2/1) gravelly loam, very dark grayish brown (10YR 3/2) dry; moderate very fine and fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; 20 percent pebbles; medium acid; gradual wavy boundary.

Bw1-22 to 26 inches; very dark grayish brown (10YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine and fine roots; 35 percent pebbles; medium acid; abrupt wavy boundary.

Bw2-26 to 38 inches; brown (10YR 5/3) very gravelly loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft. very friable, slightly sticky and slightly plastic; few fine roots; 45 percent pebbles; medium acid; abrupt wavy boundary.

2C1-38 to 39 inches; dark yellowish brown (10YR 4/4) extremely gravelly sandy loam, very pale brown (10YR 7/4) dry; massive; hard, firm, nonsticky and nonplastic; 65 percent pebbles; medium acid; abrupt smooth boundary.

2C2-39 to 60 inches; dark brown (10YR 4/3) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; single grained; loose; 80 percent pebbles and 10 percent cobbles; strongly acid.

The thickness of the solum ranges from 24 to 38 inches. The particle-size control section ranges from 35 to 50 percent coarse fragments and from 5 to 18 percent clay. The umbric epipedon is 20 to 30 inches thick.

The A horizon has value of 2 to 4 when dry and chroma of 1 or 2 when moist or dry. The Bw horizon has value of 3 to 5 when moist. It is 5 to 15 percent clay and 20 to 45 percent coarse fragments. It has faint or distinct, yellowish brown or strong brown mottles in some areas. The 2C horizon is extremely gravelly sandy loam, extremely gravelly loamy sand, or very gravelly sandy loam.

Spanaway Series

The Spanaway series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in glacial outwash and volcanic ash. Slope is 0 to 15 percent. Elevation is 100 to 400 feet. The average annual precipitation is 40 to 55 inches. the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are sandy-skeletal, mixed, mesic Andic Xerumbrepts.

Typical pedon of Spanaway gravelly sandy loam, 0 to 3 percent slopes, 4 miles southeast of Lacey; about 250 feet west and 400 feet south of the northeast corner of sec. 25, T. 36 N., R. 1 W.

A-0 to 15 inches; black (10YR 2/1) gravelly sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; loose, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; 25 percent pebbles;; strongly acid; clear smooth boundary.

Bw-15 to 20 inches; dark yellowish brown (10YR 3/4) very gravelly sandy loam, light olive brown (2.5Y 5/4) dry; weak fine subangular blocky structure; loose, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; 55 percent pebbles; medium acid; clear smooth boundary.

C-20 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly sand, yellowish brown (10YR 5/4) dry; single grained; loose; few fine roots; 80 percent pebbles, 10 percent cobbles; slightly acid.

The thickness of the solum ranges from 15 to 25 inches. The content of coarse fragments in the control section ranges from 50 to 85 percent. The weighted average texture of this section is very gravelly sand or extremely gravelly sand. The umbric epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when dry. and chroma of 1 or 2 when moist or dry. It is medium acid or strongly acid. The Bw horizon has value of 4 or 5 when dry and 3 or 4 when moist. It is very gravelly sandy loam, very gravelly loam, or extremely gravelly sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 or 4 when dry or moist. It is extremely gravelly sand or extremely gravelly loamy sand and is slightly acid or neutral.

Sultan Series

The Sultan series consists of very deep, moderately well drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 75 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are fine-silty, mixed, nonacid, mesic Aquic Xerofluvents.

Typical pedon of Sultan silt loam, 7 miles east of Lacey; about 1,000 feet east and 1,975 feet north of the southwest corner of sec. 16, T. 18 N., R. 1 E.

Ap-0 to 7 inches; dark yellowish brown (10YR 3/4) silt loam, brown (10YR 5/3) dry; moderate fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many very fine and fine tubular pores; slightly acid; abrupt smooth boundary.

BA-7 to 20 inches; dark yellowish brown (10YR 4/4) silt loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine and fine tubular pores; slightly acid; clear wavy boundary.

Bw1-20 to 25 inches; dark brown (10YR 3/3) silt loam, grayish brown (2.5Y 5/2) dry; common fine prominent red (2.5YR 5/8) mottles; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular pores; slightly acid; gradual wavy boundary.

Bw2-25 to 45 inches; dark brown (10YR 4/3) silt loam, light brownish gray (10YR 6/2) dry; common medium prominent red (2.5YR 5/8) mottles; moderate medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; slightly acid; gradual wavy boundary.

C-45 to 60 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common medium prominent dark brown (7.5YR 4/4) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; slightly acid.

The soils are slightly acid or neutral in the control section and range from slightly acid to strongly acid below a depth of 40 inches. Mottles that have chroma of 3 or more are at a depth of more than 20 inches.

The Ap horizon has hue of 10YR, value of 3 or 4 when moist. and chroma of 3 or 4 when dry. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It has thin strata of fine sandy loam to silty clay loam. The C horizon has hue of 10YR, value of 5 to 7 when moist. and chroma of 2 when moist.

Tacoma Series

The Tacoma series consists of deep, very poorly drained soils on flood plains and deltas. These soils formed in alluvium that has a high content of volcanic ash. Slope is 0 to 1 percent. Elevation is 0 to 20 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

These soils are coarse-silty, mixed, acid, mesic Sulfic Fluvaquents.

Typical pedon of Tacoma silt loam, 6 miles northeast of Lacey; about 1,000 feet north and 300 feet west of the southeast corner of sec. 31, T. 19 N., R. 1 E.

Oe-3 inches to 0; mat of fine grass roots.

A-0 to 7 inches; dark brown (10YR 3/3) silt loam. grayish brown (10YR 5/2) dry; many medium distinct dark brown (7.5YR 4/4) mottles; moderate fine angular blocky structure; friable, nonsticky and slightly plastic; many medium and fine roots; extremely acid; abrupt smooth boundary.

Cg1-7 to 23 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; many fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium prismatic structure; friable, slightly sticky and slightly plastic, many medium and fine roots; extremely acid; abrupt smooth boundary.

Cg2-23 to 40 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; many fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure; friable, nonsticky and slightly plastic; few fine roots; extremely acid; clear smooth boundary.

Cg3-40 to 50 inches; grayish brown (10YR 5/2) silt loam, gray (10YR 6/1) dry; massive; friable, slightly sticky and slightly plastic; extremely acid; abrupt smooth boundary.

2Cg4-50 to 60 inches; dark greenish gray (5GY 4/1) clay; common medium distinct brown (7.5YR 4/4) mottles; massive; friable, very sticky and very plastic; few fine tubular pores; strongly acid.

The soils are more than 60 inches deep, but the rooting depth is limited by the water table unless the plant is hydrophytic. Some pedons have layers of muck 1 to 4 inches thick. These layers have a cumulative thickness of less than 16 inches. The content of weighted organic carbon is less than 12 percent in the control section.

The A or Ap horizon has hue of 10YR or 5Y, value of 3 or 4 when moist, and chroma of 1 or 2 when moist. It has faint or distinct mottles. It is strongly acid to extremely acid. The Cg horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 to 6 when moist and 4 to 8 when dry and chroma of 0 to 2 when moist or dry. It has faint to prominent mottles. It is very strongly acid or extremely acid. The 2Cg horizon is stratified clay to sand. It varies in texture within short distances. It is very strongly acid or extremely acid. The depth to this horizon is more than 60 inches in some areas.

Tenino Series

The Tenino series consists of moderately deep, well drained soils on terminal moraines. These soils formed in glacial till over glacial outwash. Slope is 3 to 65 percent. Elevation is 50 to 400 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are coarse-loamy, mixed, mesic Dystric Entic Durochrepts.

Typical pedon of Tenino gravelly loam, 3 to 15 percent slopes, 2 miles northwest of Littlerock; about 800 feet east and 400 feet north of the southwest corner of sec. 27, T. 17 N., R. 3 W.

A1-0 to 5 inches; dark reddish brown (5YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; 30 percent pebbles; many very fine, fine, medium, and coarse roots; many very fine tubular pores; strongly acid; clear smooth boundary.

A2-5 to 11 inches; dark yellowish brown (10YR 3/4) gravelly loam, dark brown (10YR 4/3) dry; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; 30 percent pebbles; many fine, medium, and coarse roots; many very fine tubular pores; medium acid; clear smooth boundary.

Bw1-11 to 21 inches; dark brown (7.5YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; 30 percent pebbles;

common fine, medium, coarse roots; many very fine tubular pores; medium acid; clear smooth boundary.

Bw2-21 to 36 inches; dark yellowish brown (10YR 4/4) gravelly sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; 30 percent pebbles; common fine and medium roots; many very fine pores; medium acid; abrupt wavy boundary.

Bqm-36 to 40 inches; yellowish brown (10YR 5/4) very gravelly loam, very pale brown (10YR 7/3) dry; massive; very hard, very firm; fine roots in cracks; medium acid; clear smooth boundary.

2C-40 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly sandy loam, light gray (10YR 7/1) dry; single grained; loose, nonsticky and nonplastic; 70 percent pebbles; very few fine roots; medium acid.

Depth to the Bqm horizon ranges from 25 to 40 inches. The content of coarse fragments in the control section ranges from 20 to 35 percent, including as much as 10 percent cobbles.

The A horizon has hue of 10YR, 7.5YR, or 5YR when moist and 10YR or 7.5YR when dry, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. The Bw horizon has hue of 7.5YR to 5Y, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist or dry. It is gravelly sandy loam or gravelly loam. The Bqm horizon ranges from 50 to 80 percent pebbles. It is 4 to 10 inches thick and is weakly cemented. The 2C horizon is extremely gravelly loamy sand or extremely gravelly sandy loam. It ranges from 60 to 90 percent pebbles and from 0 to 10 percent cobbles.

Tisch Series

The Tisch series consists of deep, very poorly drained soils in upland depressions and drainageways. Drainage has been altered by tiling. These soils formed in diatomaceous earth, volcanic ash, and alluvium. Slope is 0 to 3 percent. Elevation is 50 to 200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial, nonacid, mesic Mollic Andaquepts.

Typical pedon of Tisch silt loam, 3 miles south of Yelm; about 500 feet east and 300 feet north of the southwest corner of sec. 5, T. 16 N., R. 2 E.

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

A-6 to 11 inches; very dark grayish brown (10YR 3/2) silt, grayish brown (10YR 5/2) dry; few fine faint yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; medium acid; abrupt smooth boundary.

C1-11 to 22 inches; dark grayish brown (10YR 4/2) silt, light gray (10YR 7/2) dry; few fine faint yellowish brown (10YR 5/8) mottles; weak thick platy structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; common very fine and fine tubular pores; medium acid; abrupt smooth boundary.

C2-22 to 30 inches; dark brown (10YR 4/3) silt, very pale brown (10YR 7/3) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; common very fine and fine pores; slightly acid; abrupt smooth boundary.

C3-30 to 50 inches; very dark brown (10YR 2/2) silt, grayish brown (10YR 5/2) dry; massive; slightly hard, firm, slightly sticky and slightly acid; abrupt smooth boundary.

20a-50 to 60 inches; black (10YR 2/1) muck, dark grayish brown (10YR 4/2) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine tubular pores; medium acid.

The soils are neutral to strongly acid throughout. The A horizon has hue of 10YR to 5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry. The content of organic matter in this horizon is as much as 20 percent. The C horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 to 4 when moist and 4 to 8 when dry and chroma of 0 to 3 when moist or dry. It is silt or silt loam. Some pedons have no layers of sapric material.

Vailton Series

The Vailton series consists of deep, well drained soils on mountainsides. These soils formed in colluvium and residuum derived from siltstone and shale mixed with volcanic ash. Slope is 5 to 65 percent. Elevation is 1,700 to 2,500 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 130 to 170 days.

These soils are medial, frigid Andic Haplumbrepts.

Typical pedon of Vailton silt loam, 5 to 30 percent slopes. 12 miles southeast of Yelm; about 400 feet west and 1,975 feet south of the northeast corner of sec. 21, T. 15 N., R. 2 E.

A1-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; many fine tubular pores; 5 percent fragments of soft siltstone; strongly acid; clear wavy boundary.

A2-10 to 15 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; common fine, medium, and coarse roots; many fine tubular pores; 10 percent fragments of soft siltstone; strongly acid; clear wavy boundary.

Bw-15 to 30 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; common fine and medium roots; many fine tubular pores; 15 percent fragments of soft siltstone; strongly acid; clear smooth boundary.

BC-30 to 42 inches; dark brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; common fine and medium roots; many fine tubular pores; 40 percent fragments of soft siltstone; strongly acid; clear wavy boundary.

C-42 to 48 inches; dark yellowish brown (10YR 6/4) silty clay loam, dark yellowish brown (10YR 4/4) dry; massive; hard, firm, sticky and plastic; few medium roots; many fine tubular pores; 70 percent fragments of soft siltstone; strongly acid; clear wavy boundary.

Cr-48 inches; weathered siltstone.

The depth to paralithic contact is 40 to 60 inches. Fragments of soft rock make up 15 to 35 percent of the particle-size control section. The soils are medium acid or strongly acid throughout.

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. The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry. and chroma of 3 or 4 when moist or dry. It is silty clay loam or clay loam. Fragments of soft rock make up 15 to 40 percent of the Bw horizon and 60 to 90 percent of the C horizon.

Wilkeson Series

The Wilkeson series consists of very deep, well drained soils on uplands and mountains. These soils formed in material weathered from andesite and basalt. Slope is 5 to 40 percent. Elevation is 600 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 125 to 175 days.

These soils are fine-loamy, mixed, mesic Ultic Haploxeralfs.

Typical pedon of Wilkeson silt loam, 5 to 20 percent slopes, 2 miles south of Vail; about 650 feet west and 300 feet south of the northeast corner of sec. 3, T. 15 N., R. 1 E.

A1-0 to 5 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; strong very fine, fine, and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; medium acid; abrupt smooth boundary.

A2-5 to 11 inches; dark brown (7.5YR 3/2) silt loam, brown (10YR 5/3) dry; strong fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine and fine tubular pores; medium acid; gradual wavy boundary.

Bt1-11 to 23 inches; dark yellowish brown (10YR 4/4) gravelly silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine and fine tubular pores; few thin clay films on faces of peds and lining pores; 15 percent angular pebbles; medium acid; clear wavy boundary.

Bt2-23 to 47 inches; dark brown (7.5YR 4/4) gravelly silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine and fine tubular pores; common moderately thick clay films on faces of peds and lining pores; 20 percent angular pebbles; strongly acid; gradual wavy boundary.

Bt3-47 to 60 inches; dark brown (7.5YR 4/4) gravelly clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine tubular pores; few moderately thick clay films

on faces of peds and lining pores; 20 percent angular pebbles; strongly acid.

The soils are strongly acid or medium acid throughout. The particle-size control section ranges from 18 to 35 percent clay and from 15 to 25 percent coarse fragments.

The A horizon has chroma of 2 or 3 when moist or dry. The Bt 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 or dry. It is clay loam or silty clay loam.

Yelm Series

The Yelm series consists of deep, moderately well drained soils on terraces. These soils formed in glacial outwash. Slope is 0 to 30 percent. Elevation is 25 to 300 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 170 to 200 days.

These soils are medial, mesic, Aquic Dystric Xerochrepts.

Typical pedon of Yelm fine sandy loam, 0 to 3 percent slopes, 2 miles southeast of Olympia; about 950 feet east and 1,950 feet south of the northwest corner of sec. 31, T. 18 N., R. 1 W.

Apc-0 to 8 inches; dark brown (7.5YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine roots; many very fine interstitial pores; 20 percent shotlike aggregates; medium acid; abrupt smooth boundary.

Bw1-8 to 17 inches; dark yellowish brown (10YR 4/4) fine sandy loam, pale brown (10YR 6/3) dry; few faint greenish gray (5GY 6/1) mottles; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine roots; many very fine interstitial pores; medium acid; clear wavy boundary.

Bw2-17 to 36 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine faint very dark grayish brown (2.5Y 3/2) organic masses 1 to 2 inches in diameter; few fine faint greenish gray (5GY 6/1) mottles; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; many very fine interstitial pores; medium acid; gradual wavy boundary.

Bw3-36 to 46 inches; olive brown (2.5Y 4/4) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; many very fine interstitial pores; medium acid; abrupt smooth boundary.

C-46 to 60 inches; light olive brown (2.5Y 5/4) loamy sand, light gray (2.5Y 7/2) dry; loose; nonsticky and nonplastic; weakly smeary; slightly acid.

The soils are medium acid or slightly acid throughout. The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. The Bw horizon has hue of 10YR or 5Y, value of 4 or 5 when moist and 5 to 8 when dry, and chroma of 2 to 4 when moist or dry. It has greenish gray (5GY 6/1 or 5/1) mottles. It is dominantly fine sandy loam, but in some areas it has lenses of silt loam or loamy sand.

Formation of the Soils

Soil is a product of the soil-forming processes acting on material deposited or accumulated through geologic forces. The important factors in soil formation are parent material, climate, living organisms, relief, and time.

Climate and living organisms, particularly vegetation, are the active forces in soil formation. Their effect on the parent material is modified by topography and by the length of time that the parent material has been in place. The relative importance of each factor differs from place to place. Occasionally one factor dominates and, therefore, controls development of most of the properties of the soil, but normally all five factors interact to determine the kind of soil that develops in any given place.

Parent Material

Thurston County can be divided into seven major and somewhat distinct geologic areas (*4, 10, 13, 17, 26).* These areas do not form contiguous units everywhere, nor can they be considered discreet physiographic provinces. They are described in the following paragraphs.

Bald Hills. This area is along the southern boundary of Thurston County. Virtually all of the bedrock within this area is mapped as Tertiary (2 to 50 million years old) volcanic rocks consisting of basalt, andesite, and related sedimentary deposits. The upper part of the bedrock is intensively weathered in many places. The weathering has resulted in the formation of soils that are many feet thick. Most of the soils in the Baumgard-Wilkeson, Pheeney-Mal, Melbourne-Centralia, and Salkum-Prather associations formed in these deposits.

Clam Mountain is an upland surface in this geologic area. It has a very flat summit. The nature of this surface suggests a previous cycle of erosion occurring in the early Pleistocene or perhaps the Pliocene. The surface is being incised by the present cycle of erosion, which apparently started shortly before Wisconsin time. Upland surfaces of similar topography are in areas both east and west of Clam Mountain. They are mantled by deposits of the Logan Hill Formation. The Baumgard-Wilkeson and Pheeney-Mal associations are in this area.

Black Hills. This area is along the western boundary of the county. The volcanic rocks in this area are of Tertiary age and are underlain by basaltic rocks of Eocene and late Eocene age (37 to 53 million years old). In many places the basalt is columnar or is massive and glassy. Most of the soils in the Olympic-Raught and Schneider-Delphi associations formed in this parent material.

The Black Hills show evidence of one or more previous erosion cycles. The evidence of these cycles, however, is not so strongly expressed as that in the Bald Hills. Capitol Peak and the Larch Mountains are probably remnants of an erosion surface of low relief that has been almost completely destroyed by the present erosion cycle. Capitol Peak is mostly bare, fresh rock, but the lower slopes are covered with very thick, red residual soil that apparently thickens towards the lower elevations because of soil creeping. Outcrops on the lower slopes occur only where streams or artificial cuts have removed the soil.

Michigan Hill. This area is in the southwest corner of the county. The Tertiary core of these uplands consists of poorly consolidated, tuffaceous sandstone and siltstone sediments of the Lincoln Formation (22 to 37 million years old). The soils in the Salkum-Prather and Melbourne-Centralia association formed in these sediments.

Maytown Upland. This upland is in the south-central part of the county, between the towns of Maytown and Tenino. In this area Wisconsin-age drift and deposits of the Logan Hill Formation (1 to 2 million years old) form a generally thick mantle over a core of Tertiary tuffaceous siltstone, andesite, and basalt and marine, nonmarine, and brackish-water sedimentary rocks and interbedded coal deposits of the Skookumchuck, McIntosh, and Northcraft Formations (37 to 53 million years old). The soils in the Cathcart-Tenino association formed in these parent materials.

Kame-Kettle Area. This area is in the east-central part of the county, between the towns of Rainier and Yelm and around Clear Lake. Most of the materials were deposited as ice-contact outwash laid down as an end moraine of the Yelm lobe of the Vashon glacier. The area has a kame and kettle topography formed through the deposition of drift in contact with wasting ice. Closed depressions (kettles) are numerous. Many contain lakes. but most are dry. The areas of hummocky topography consist mainly of rudely stratified outwash of sand and gravel that contains local lenses or pods of till. Baldhill. Indianola, and Kapowsin soils formed in this area.

Peninsular Area. This area is in the. northern part of the county and is geologically and topographically similar to the coastal regions and islands of the remainder of the southern Puget Sound region. Vashon-age glacial till mantles much of the surface, and the topography was fashioned by the action of the advancing Vashon glacier. In a few areas where it is more than 20 feet thick, the till is underlain by a complex assortment of Wisconsin-age deposits, including Vashon-advance outwash, Colvos Sand, the Kitsap Formation, and Salmon Springs Drift. Most of the soils in the Alderwood-Everett association formed in Vashon till.

Prairie Area. This area is mainly in the central part of the county. It was covered by glacial meltwater during the receding stages of the Vashon glacier and consequently is of gentle relief. The surface deposits are almost entirely Vashon recessional outwash. Most of the soils in the Spanaway-Nisqually association formed in these deposits. Most of the southern prairies and those adjacent to the Nisqually River are underlain by gravelly outwash, whereas the northern prairies bear a mantle of silty and sandy outwash of varying thickness. Some valley areas have been subsequently covered with postglacial alluvium.

Almost all of the southern gravelly prairies have a thin mantle of black, gravelly soil that allows rapid percolation of water to the very permeable gravel beneath. These prairies are used mainly for grazing. Some crop production is possible if the soil is irrigated and fertilized. Information on the subsurface is inadequate. Well logs, however, indicate a hardpan layer within 40 feet of the surface. This hardpan is tentatively described as Salmon Springs Drift (35,000 to 40,000 years old), but in places it may be Vashon till.

The northern sand-covered prairies, which include the Nisqually and Yelm soils, are generally the most productive agricultural areas because they retain more moisture than the gravel prairies. The sand varies greatly in thickness. In the vicinity of Olympia, it is very thick. In most places it overlies recessional gravel; near Olympia it overlies fine grained deposits of pre-Salmon Springs age.

Although it differs genetically, the area north of the Mima Prairie and east of Waddell Creek is included in the Prairie Area. The surface deposits occur as a Vashon end moraine. This region has moderate to steep relief and is heavily forested in most places. The deposits in the southern part of the area are Vashon ice-contact outwash. The topography is pitted, as is typical of end moraines. In the northern part of the area, the Vashon outwash is thinner. It most likely overlies thick deposits of Salmon Springs gravel, which is probably part of a Salmon Springs end moraine that was modified by erosion in pre-Vashon time. Tertiary volcanic rock probably underlies the Wisconsin-age deposits in the entire area.

Mima mounds are in areas underlain by Vashon recessional gravel throughout the southern part of the Prairie Area, from Weir Prairie westward. They are a striking physiographic feature where they are well developed. They range in size from barely perceptible swells on the prairie surface to a maximum height of about 7 feet on the Mima and Rocky Prairies. They range from 6 to 70 feet in diameter. The average diameter is about 40 feet.

Some areas include well developed mounds and a few incipiently developed mounds, whereas other areas include only incipiently developed mounds and no large ones. Most of the mounds are closely but irregularly spaced, so that mound areas are roughly equal to intermound areas, but a few isolated mounds are evident on otherwise moundless prairies. The mounds may occur on several terrace levels of any one prairie, such as the Weir Prairie. The higher terraces generally have the best developed mounds. The mounds consist of black, gravelly silt and sand underlain by rudely stratified sand and gravel outwash. The origin of the mounds has long been a controversial subject that has given rise to numerous speculations.

Climate

Climate is directly or indirectly responsible for variations in plant and animal life and for major differences among soils. It affects the rate of weathering of parent materials and the rate of removal and redeposition of material by water, wind, and glaciers.

Thurston County has a marine climate. Summers are cool and dry, and winters are mild, but wet and cloddy. Rainfall is heavier and temperatures are lower at the

higher elevations in the mountains than in the valleys. Rains, however, are gentle. They moisten the soil much more effectively than torrential downpours. The rainwater soaks into the soil and percolates downward. In regions where rainfall is high, soils are more highly leached than they are in semiarid and desert regions. For this reason, most of the bases (nutrient cations) have been leached out of the soils in the county. The soils are generally acid.

Climate has a marked effect on the productivity and fertility of soils. At the higher elevations, the growing season is shorter, spring frost is later, fall frost is earlier, and the average annual temperature is lower than at the lower elevations. Soils at the higher elevations are, therefore, generally less productive than those at the lower elevations. For example, the Bunker soils produce about 171 cubic feet of Douglas-fir per acre per year at elevations below 1,800 feet, while the similar Lates soils, which occur at elevations ranging from 1,800 to 2,600 feet, produce only about 142 cubic feet of Douglas-fir per acre per year.

Living Organisms

All life on and in the soil affects soil formation. The raw soil material is first invaded by simple forms of life, such as bacteria and fungi, that grow and multiply. Mosses and lichens appear, followed by grasses, shrubs, and trees.

Plants and animals furnish organic matter to the soil and transfer plant nutrients from the lower layers of the soil to the upper ones. Grasses and trees drop their dead leaves and trunks on the surface of the soil, and these furnish an enormous quantity of organic material to the soil over a long period. The roots of these plants permeate the soil. sometimes to a depth of many feet, and make it more porous than the parent material. The decay of roots. especially those of grasses, also adds organic matter to the soil. The organic material from grasses and leaves is consumed by worms, bacteria, and fungi and is thus mixed with the mineral soil material.

Deep-rooted plants absorb water from horizons deep in the profile. The water is absorbed into the stems, trunks, and leaves. It includes a certain amount of dissolved mineral material. When the leaves fall and the plants themselves decay, these minerals are returned to the surface of the soil. This process enriches the surface layer. Nutrient cycling is an important process in humid regions where there is a great amount of leaching. Nutrients released from organic material through the process of decaying can be leached from the surface and carried downward by percolating water. Plant roots may intercept the downward moving water and carry the water and dissolved nutrients back up to the part of the plants above the surface.

Soils that formed under grass and brackenfern, both of which have fibrous, deep-reaching roots, have a deep, very dark brown to black surface layer that is high in content of organic matter. Spanaway and Nisqually are examples of soils that formed under a partial cover of brackenfern. Soils that formed under coniferous and deciduous vegetation generally have a thinner, very dark grayish brown to brown surface layer that is lower in content of organic matter. The Rainier soils are an example.

The decay of forest debris causes the formation of organic acids of various kinds, including carbonic acid. These acids hasten the leaching process of soils and soil material. Most forested soils in humid regions are medium acid or strongly acid. For example, Bunker soils, are medium acid.

The remains of sedges, rushes, moss, Labrador tea, and other plants that tolerate wetness and have grown in standing water have accumulated and formed peat in bog areas. Mukilteo muck is an example of a soil that formed in these areas (7).

Animals convert plant remains into organic matter. They eat the plants, and the waste is returned to the soil, where it is further transformed into organic matter.

Burrowing animals, such as mice, moles, and mountain beaver, mix soil horizons and thus supply a certain amount of fresh parent material to the surface layer, which has been leached of plant nutrients. In places the steep and very steep Bunker soils have been subject to mixing and churning by the mountain beaver. Earthworms consume and thus break down organic matter. As a result, they enrich many tons of soil per acre each year. In many places the burrows of worms or small animals extend deeply into the soil, and the excavated materials are spread out over the surface. When the burrows are abandoned, the cavities fill with surface soil that is rich in organic material. It is possible for roots to grow rapidly through some of this relatively rich material and to penetrate more deeply into the substratum than would otherwise be possible.

Micro-organisms play an important part in the development of soils. They change raw plant material into organic matter. Bacteria and various kinds of fungi help to decompose dead leaves and other plant remains, which are then incorporated into the soil as organic matter. Microscopic soil animals and insects also live on these plant remains and help to convert them into soil material.

Relief

The shape of the landscape influences soil formation through its effect on the amount of runoff and erosion on the surface, the stability of the soil material, and soil drainage. Runoff becomes more rapid as slope increases. Consequently, geologic erosion on steep slopes probably has contributed more to the parent material of soils on toe slopes, benches, valleys, and allvuial bottom land than erosion on broad, relatively flat plains, uplands, and ridges. Once established, vegetation stabilizes the soils on all slopes, so that the rate of erosion decreases and the rate of profile development increases.

When soils are exposed because of clear-cut harvesting, road construction, forest fires, or farming, the potential for erosion increases. Erosion on bare slopes is almost always greater on the steeper terrain, although unprotected soils in undulating to rolling areas are subject to severe losses during the rainy season or under saturated conditions. Soil material may be moved only short distances, rounding off hilltops and filling nearby swales. Sheet erosion generally carries away surface soil. Rill and gully erosion can cut into the subsoil and substratum. Mass-wasting on steep slopes can remove all soil material above the regolith, as it has done in some areas of the steep Centralia and Melbourne soils following timber harvest.

Soils that formed in broad, nearly level to moderately sloping areas in the part of the county that was not glaciated are typically deeper, have fewer rock fragments (or fragments that are highly weathered or very soft), and are more strongly developed than soils on steep or colluvial side slopes. Soil creep is a problem on steep soils. It prevents colluvial soils, such as the Baumgard and Schneider soils, from developing a clay-rich B horizon and from weathering as rapidly or as deeply into the regolith as the associated, less steep Olympic and Wilkeson soils.

Relief results in the removal of runoff from hillsides and the collection of water in swales, basins, and low spots, as is indicated by the soils in the Salkum-Prather association on rolling glaciofluvial outwash plains. The well drained Salkum soils commonly are in the higher positions on the landscape, such as the broad, slightly rounded upper part of terraces, hills, and ridges, from which water is readily drained. The moderately well drained Prather soils are in the flatter areas below the Salkum soils. The somewhat poorly drained Galvin and Scamman soils commonly are in the lowest landscape positions. such as toe slopes, depressional areas, and drainageways, which are most likely to receive and collect runoff.

Although the Salkum soils are silty clay and clay and are moderately slowly permeable, they are in landscape positions that keep them well drained. They are dark brown, brown, and red, colors which indicate good aeration and drainage. Consequently, they support stands of Douglas-fir. The undrained Lacamas soils are ponded in winter and spring. They are poorly aerated and are mottled gray (gleyed) clay below the surface layer. When dry in summer, this clay is hard and impenetrable. As a result, these soils support mixed deciduous trees, including red alder and Oregon ash, and limited types of ground cover, such as wetland plants and salmonberry brush. Where conifers do grow, they either are poor stands of Douglas-fir or are lodgepole pine. The differences in drainage, color, aeration, fertility, and plant cover between the Salkum and Lacamas soils and between the Salkum and Lacamas soils and the intermediate Prather and Scamman soils appear to be mainly the result of their relative positions on the landscape.

Soils on bottom land formed in alluvium deposited by runoff from the surrounding uplands and by floodwater from the adjacent streams and rivers that carried material down valleys from the higher elevations. The frequency and length of flooding can affect soil formation and land use. The well drained Chehalis and Newberg soils are subject only to minor flooding in winter and early in spring; therefore, fertility and cropping are not seriously affected. Minor flooding can be beneficial because it adds nutrients and silty fines to the soil. The poorly drained Godfrey soils are occasionally flooded. Unless the soils are drained, they are waterlogged much of the year and do not dry out sufficiently until midsummer. As a result, soil development is slower than in other soils. The natural vegetation is mainly wetland plants. Semiahmoo soils are in depressions on flood plains or bottom land where drainage outlets are limited. Runoff is very slow or ponded, and water becomes stagnant. These soils mainly support rushes and sedges. They formed in the dead plant material that accumulated as muck and peat.

Time

The length of time required for the formation of a given kind of soil depends on the interaction of climate with the kinds and amounts of living organisms, the parent material, and relief. In time a soil profile that has two or more horizons develops. Young soils have

weakly expressed horizons, while older soils have strongly expressed ones. Distinct horizons develop more slowly in steep soils than in nearly level soils, and soils in arid climates develop more slowly than soils in humid climates.

Spanaway and Salkum soils formed under nearly identical climatic conditions. They are also in close geographic proximity. Salkum soils formed in the oldest glacial deposit in the county. Deposited between 325,000 and 1.5 million years ago, the glacial outwash was originally silt, sand, and hard, rounded pebbles and cobbles. Time, however, has resulted in weathering to the point that Salkum soils are now clayey. The B horizon exhibits thick, continuous clay films on faces of peds and lining pores. The mineralogy of the clay fraction of these soils includes kaolinite, a clay that indicates a very high degree of weathering. In the upper part of the profile, the rock generally is totally weathered and is no longer recognizable. In the lower part, the rock is unconsolidated or very soft, and the hardest fragment can easily be cut with a knife.

Spanaway soils formed in very coarse glacial outwash that is only 12,000 years old. The outwash is primarily very gravelly and cobbly sand. These soils have not weathered greatly in comparison to the much older Salkum soils. There has been no translocation of clays and little weathering of rock. The B horizon is thin and weakly expressed. The C horizon is extremely gravelly sand. Rounded pebbles and cobbles are very hard throughout the profile. Perhaps in 300,000 to 1 million years, if the climate does not change, Spanaway soils will more closely resemble Salkum soils.

Newberg soils formed in young alluvium on flood plains. They are weakly developed, and their parent material shows little evidence of change other than a darkening of the A horizon. There is no evidence of clay movement.

The slumping of soil material on hills alters residual soils by burying, shattering, and mixing the material in the slumped block. New surfaces are exposed to weathering, which results in local differences in age and in degree of development.

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Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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

Alluvial 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.

Alluvial terrace. A stream terrace made up of unconsolidated alluvium (including gravel), formed through renewed downcutting of the flood plain or valley floor by a rejuvenated stream or through the later covering of a terrace with alluvium.

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

Angle of repose. The maximum angle of slope at which loose, cohesionless material will come to rest on a pile of similar material.

Animal-unit-month (AUM). The amount of forage required by one mature cow of approximately 1.000 pounds weight, with or without a calf, for 1 month.

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

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

Low	less than 3.75
Moderate	3.75 to 7.5
High	more than 7.5

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.

Basal till. Compact glacial till deposited beneath the ice.

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.)

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Chemical treatment. Control of unwanted vegetation by use of chemicals.

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.

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.

Colluvial side slope. Any slope upon which the process of mass-wasting is now or has been active, resulting in an incorporation of fractured chips or rock fragments into the soil matrix. This process usually is classified as soil creep. More rapid forms of mass movement do occur, such as earth flows, rockslides, avalanches, and falls, on steeper slopes.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Compaction. The process by which a soil mass loses pore space and achieves a higher bulk density in response to increased load or compressive stress.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

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

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.

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.

Cut slope. The uphill slope left after earth-moving equipment has excavated or cut into the hillside to make a roadbed.

Delta. A body of alluvium whose surface is nearly flat and fan shaped, deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

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. *Erosion* (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym; natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a

catastrophe in nature; for example, fire that exposes the surface.

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.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

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

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Extrusive rock. Igneous rock derived from deep-seated molten matter (magma) emplaced on the earth's surface.

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

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

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, and clay.

Firebreak. Area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of men and equipment in fire fighting. Designated roads also serve as firebreaks.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

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.

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.

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

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

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

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

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not

prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

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

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

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

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head out. To form a flower head.

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 uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows;

O horizon.-An organic layer of fresh and decaying plant residue.

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

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.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is

absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

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

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows;

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1 25 to 1.75	moderately high
1 75 to 2.5	high
More than 2.5	very high

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

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-

Border.-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.-Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).-Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters. porous tubing, or perforated pipe.

Furrow.-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

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

Subirrigation.-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

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.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

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.

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

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

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

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

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

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

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. 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 chroma. For example, a notation of 10YR 6/4 is a color in hue of 10YR, value of 6, and chroma of 4.

Narrow ridgetops. Sharp-crested, linear elevations occurring either as an independent hill or as part of a larger mountain or hill; e.g., an extended upland between valleys. These are generally between 50 and 300 feet wide at the crest and are associated with side slopes in excess of 30 percent.

Natural reforestation. The process through which seedlings become established from seed disseminated by nearby trees. The expected period needed for natural reforestation is described in the following terms; *readily,* seedlings expected to occupy the area in 2 to 5 years; *periodically,* 5 to 10 years; and *infrequently, 10* to 20 years.

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.

Observed rooting depth. Depth to which roots have been observed to penetrate.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

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

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

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

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

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.

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

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a landsurface, considered collectively.

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

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

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

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

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

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

Salty water (in tables.) Water that is too salty for consumption by livestock.

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.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Scarification. The act of abrading, scratching, loosening, crushing. or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through

the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

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 substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

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.

Skidding. A logging system involving either wheeled or tracked equipment that pulls a log from the area in which it was cut to a loading area. The disturbed area left after skidding is referred to as the "skid trail" or "skidding path."

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Slump. A landslide characterized by a shearing and rotary movement of a generally independent mass of rock or earth along a curved slip surface (concave upward) and about an axis parallel to the slope from which it descends, and by backward tilting of the mass with respect to that slope, so that the slump surface often exhibits a reversed slope facing uphill.

Slump-slide topography. A soil landscape characterized by slumps of varying frequency.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil creep. The gradual, steady downhill movement of soil and loose rock material on slopes that range from sloping to very steep.

Soil depth. Refers to depth of the soil profile. Classes of soil depth are *shallow,* 10 to 20 inches; *moderately deep,* 20 to 40 inches; *deep,* 40 to 60 inches; and *very deep,* more than 60 inches.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows;

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation

are active. The solum in soil consists of the A. E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum,

Stable soil surfaces. Those soil landscapes which, as a result of favorable underlying geologic material, low annual precipitation, and chemical resistance to weathering, presently are expressed as smooth, nearly level, and weakly dissected local areas. Sufficient time has elapsed for moderately deep or deep profile development.

Stocking. The degree to which an area is effectively covered with living trees. Fully stocked stands have as many trees per acre as can properly use the growing space available.

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. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the E horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

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. '

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

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.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

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 a 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.

Yield (woodland). The volume of wood that can be harvested from a forest stand; usually expressed in cubic feet per acre or board feet per acre.