SOIL SURVEY

Skamania County Washington

Series 1940, No. 20

Issued July 1956

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with the
WASHINGTON AGRICULTURAL EXPERIMENT STATION
and the
WASHINGTON STATE PLANNING COUNCIL

How to use THE SOIL SURVEY REPORT

FARMERS who have lived in one locality for a long time learn about differences among soils on their own farms and on the farms of their immediate neighbors. What they do not know, unless soil surveys have been made, is how nearly their soils are like those at experiment stations or in other places where improved methods of farming have been successful. Their soils may be entirely different from those on which the improved methods were tried, and, if so, a change to the new methods may be an expensive failure. This soil survey report, like others of its series, is designed to help farmers avoid some of the risk and uncertainty involved in trying new methods of management. It maps and describes the agricultural soils of Skamania County and allows farmers to compare their soils with those on which new methods have been successful.

SOILS OF A PARTICULAR FARM

All the soils of Skamania County are shown on the soil map that accompanies this report. To find what soils are on a farm, locate the farm on the soil map. This is done by using roads, streams, villages, dwellings, and other landmarks to locate the boundaries.

The next step is to identify the soils on the farm. Suppose, for example, one finds on a farm an area marked with the symbol Cc. Look among the rectangles in the margin of the colored map and find the one with Cc printed on it. Just below this rectangle is the name of the soil—Chemawa shotty loam, 5 to 15 percent slopes. All areas of this soil have the same symbol and the same color, wherever they appear on the map.

What is this soil like? How is it used? This information will be found in the section, Soil Types and Phases. How much will this soil produce? The answer to this question will be found in table 4, where estimated average yields are given for all the soils of the county. Compare the yields for this soil with those for other soils in the county.

SOILS OF THE COUNTY AS A WHOLE

A general idea of the soils of the county is given in the section, Soils, which tells about the principal kinds of soils, where they are found, and how they are related to one another. After reading this section, study the soil map and notice how the different kinds of soils tend to be arranged in different parts of the surveyed area. These patterns are likely associated with well-recognized differences in types of farming, land use, and land use problems.

A newcomer to the county, especially if he considers buying a farm, will want to know about the climate; the types and sizes of farms; the principal farm products and how they are marketed; the kinds of farm tenure; availability of roads, railroads, airfields, and electric service; industries of the county; and cities, villages, and population characteristics. Information about all of these will be found in the sections, General Nature of the Area, Agriculture, and Additional Facts About Skamania County.

Those interested in how the soils of the county were formed and how they are related to the great soil groups of the world should read the section, Morphology and Genesis of Soils.

This publication on the soil survey of Skamania County, Wash., is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

the

WASHINGTON AGRICULTURAL EXPERIMENT STATION

and the

WASHINGTON STATE PLANNING COUNCIL

Series 1940, No. 20 Issued July 1956

SOIL SURVEY OF SKAMANIA COUNTY,[1] WASHINGTON

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United States Department of Agriculture in cooperation with the Washington Agricultural Experimental Station and the Washington State Planning Council

CONTENTS

[1] Skamania County is included in an earlier reconnaissance soil survey of southwestern Washington (*6*), but the earlier survey was not so intensive or detailed as this survey.

[2] Field work for this survey was done under direction of the Division of Soil Survey when it was a part of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration. Soil Survey was transferred to the Soil Conservation Service November 15, 1952.

THIS SURVEY covers the part of Skamania County used for farming, about 311 square miles along the southern border. The rest of the county is in the Gifford Pinchot National Forest. Logging is the most important industry. Farming is a secondary enterprise. The average farm covers 104 acres, and one-fourth of it is cultivated. The rest of the farm is cutover land used mainly for pasture. Many of the farmers work part time in the timber.

The principal crops are fruits and hay. The hay is fed to livestock, mainly dairy cattle. The farmers grow enough hay for their livestock but sometimes have to buy mixed feeds. Peaches and apples are the main cash crops.

This survey was made to aid farmers in planning the best use of their soils. It is a cooperative contribution from the United States Department of Agriculture, the Washington Agricultural Experient Station, and the Washington State Planning Council. Field work was completed in 1940, and, unless otherwise specifically indicated, all statements in this report refer to conditions in the county at that time.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Skamania County is located in the southwestern part of Washington (fig. 1). It is bounded by the Columbia River on the south, Clark and Cowlitz Counties on the west, Klickitat and Yakima Counties on the east, and Lewis County on the north. Stevenson, the county seat, is about 130 miles south of Seattle and 250 miles southwest of Spokane.

The total area of the county is approximately 1,676 square miles. Approximately 311 square miles is covered by this survey. This total is made up of three separate areas in the southern and west-central parts of the county. The largest area borders the Columbia River in the southwestern corner, a smaller area is in the southeastern

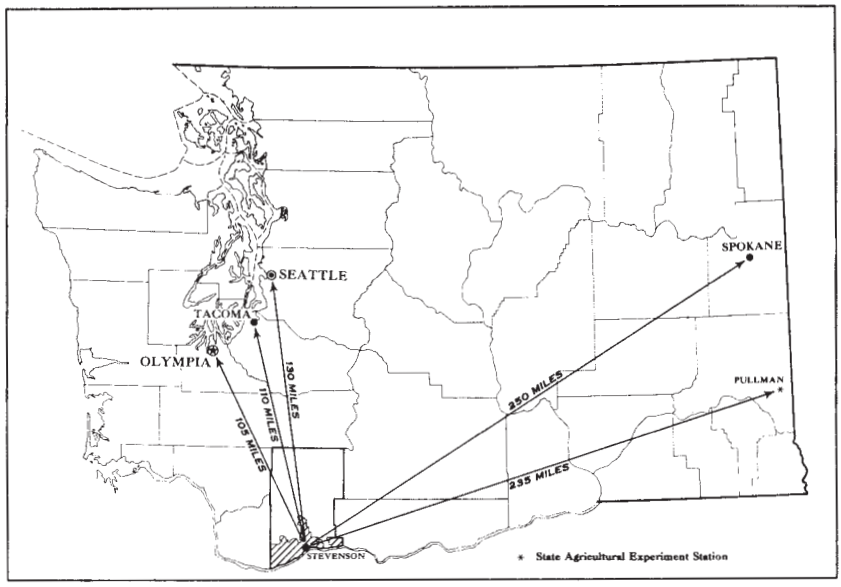

FIGURE 1.—Location of Skamania County in Washington.

corner, and the third lies along the Lewis River in the west-central part of the county. Except for about 12 square miles in the Wind River Valley, the Gifford Pinchot National Forest was not included in this survey.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The county is located in the Sierra–Cascade uplift (*3*),[3] a region characterized by high, deeply dissected mountains. Between Cape Horn and Underwood the Columbia River passes through the Cascade Mountain Range in the Columbia River Gorge, a deep canyon lined by precipitous basalt and andesite slopes.

Viewed from the higher elevations, the county has the appearance of a deeply dissected sloping plateau. Many high dissected benchlike areas from old lava flows break off about 3,000 feet above sea level, but a few small areas are covered with recent lava flows that still have constructional relief. Small benchlike areas are in the southeastern and southwestern corners of the county.

The outstanding physiographic features are rugged mountainous areas, high terraces, and river flood plains and low terraces. The areas of river flood plains and low terraces adjacent to the Columbia and Lewis Rivers are of small extent and consist chiefly of Columbia, Chehalis, Toutle, and Greenwater soils. The soils in the mountainous areas are mainly Olympic and Underwood, and those on the high terraces are principally Chemawa, Felida, Hillsboro, and Skamania.

The major part of the area is underlain by andesitic lava rock. Basalt is most common in the eastern part of the county, but extensive areas of andesite are north of Beacon Rock and northeast of Carson.

[3] Italic numbers in parentheses refer to Literature Cited, p. 92.

An area of grandioritic rock occurs in the upper part of the Washougal River Basin north of Skye School. Mixed rocks from interbedded lava rock and conglomerate from old continental deposits are on the lower mountain slopes between Stevenson and Skamania. Some of this is recent landslide material. The region north of Mount Mitchell is covered with a mantle of pumice from eruptions of Mount St. Helens.

Elevations [4] range from near sea level on the Columbia River to about 3,000 feet on the crests of the mountains in the southern part of the area. Prindle, North Bonneville, Stevenson, and Underwood are at elevations of less than 200 feet. The elevation at Carson is 500 feet. Elevations of the Lewis River range from 514 feet where it leaves the area on the west to 900 feet where it enters the area on the east. Mount Mitchell, which has an elevation of 4,015 feet, is the highest point in the area surveyed. Mount St. Helens with an elevation of 9,671 feet is in the county but outside the survey. Mount Adams with an elevation of 12,307 feet is also outside the survey, on the eastern border of the county.

Except for the Lewis River, all drainage is south to the Columbia River, which forms the southern boundary of the county. The White Salmon and Little White Salmon Rivers drain the eastern area, the Wind River drains the central part, and the Washougal River the western half of the surveyed area. The Lewis River, which receives its headwaters from both Mount Adams and Mount St. Helens, drains the northern half of Skamania County.

CLIMATE

The topography of Skamania County strongly influences the climate, which is characterized by cool, dry summers and mild, moist winters. The winds in the Columbia River Gorge blow alternately from the east and west. East winds predominate early in winter and west winds the rest of the year. The west winds—mild and moist in winter and cool in summer—blow from the Pacific Ocean and have a decided tempering effect on the climate. The east winds—warm and dry in summer and cold in winter—come from the intermountain region and are responsible for sudden changes in the weather. Winds in the belt along the Columbia River Gorge are much stronger than average for the region.

On the west side of the Cascades, rainfall increases with elevation until the crest is reached and then falls rapidly east of the mountains. Precipitation is progressively higher and temperatures lower with increasing altitude. The average annual precipitation at the Weather Bureau station at Wind River is 86.73 inches, and the average annual temperature, 48.3° F. (table 1). The area near the Lewis River has a much higher rainfall because it is west of the high mountain barrier.

Although summer days are usually cloudless, the temperature seldom rises above 80° F. July and August are dry. Most of the precipitation comes during winter, when misty rains may fall for several days at a time. Thunderstorms and hail are rare. Snow melts quickly. It lasts just a few days at the lower elevations but remains all winter at altitudes greater than 2,000 feet. Periods of freezing

[4] Data from U. S. Geological Survey topographic maps.

weather are short. High rainfall and a low evaporation rate keep the soils wet during winter, but fields are usually dry enough to cultivate at the end of February. The dry summer months favor the growing of early maturing crops and deep-rooted fruit trees.

The latest killing frost in spring was recorded on June 30 and the earliest in fall on September 12. The average date of the last frost is May 17 and the first, October 1. This is an average season of 137 days.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Wind River, Skamania County, Wash.*

[Elevation, 1,150 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Total for the driest year	Total for the wettest year	Average snowfall
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	35. 0	63	−13	16. 11	20. 24	19. 52	20. 5
January	32. 2	64	−8	14. 05	7. 49	25. 65	37. 0
February	35. 8	67	−9	9. 99	2. 23	18. 11	16. 8
Winter	34. 3	67	−13	40. 15	29. 96	63. 28	74. 3
March	41. 4	82	9	9. 91	6. 87	19. 11	12. 3
April	47. 4	92	22	5. 68	8. 97	8. 79	3. 0
May	53. 2	93	26	3. 74	2. 01	2. 50	. 2
Spring	47. 3	93	9	19. 33	17. 85	30. 40	15. 5
June	59. 2	100	29	2. 12	3. 66	. 89	0
July	64. 3	103	33	. 52	[3]	1. 21	0
August	63. 8	102	33	1. 08	. 05	1. 91	0
Summer	62. 4	103	29	3. 72	3. 71	4. 01	0
September	57. 6	96	25	3. 39	. 32	3. 56	0
October	49. 8	84	21	6. 88	1. 75	20. 13	. 2
November	40. 6	70	11	13. 26	. 56	21. 22	4. 9
Fall	49. 3	96	11	23. 53	2. 63	44. 91	5. 1
Year	48. 4	103	−13	86. 73	[4] 54. 15	[5] 142. 60	94. 9

[1] Average temperature based on a 43-year record, 1910 to 1952; highest and lowest temperatures from a 21-year record, 1910 to 1930.

[2] Average precipitation based on a 43-year record, 1910 to 1952; wettest and driest years based on a 42-year record, 1911 to 1952; snowfall on a 21-year record, 1910 to 1930.

[3] Trace.

[4] In 1929.

[5] In 1950.

VEGETATION

Skamania, more than 80 percent of which is in the Gifford Pinchot National Forest, is one of the most heavily forested counties in the State. Except for a few minor areas, it was formerly covered by a

dense stand of coniferous forest containing 25,000 to 100,000 board feet or more to the acre. The dominant forest type was Douglas-fir, but hemlock was an important associate.

The virgin timber in the surveyed areas has been largely logged off, except near the Lewis River. The forest fire of 1902 (Yacolt burn) destroyed much of the timber in the western part of the area, and subsequent fires have retarded restocking. The most completely denuded areas are on the north side of the Washougal River basin, where the ground is covered with a dense growth of bracken, some scattered brush, and a young restocking of Douglas-fir in places. The higher elevations in the forested areas are now covered with mountain hemlock, balsam fir, Pacific silver fir, and associated types. Western yellow pine is abundant in the southeastern part of the area where rainfall is less and the Underwood is the principal soil. Western redcedar grows in scattered areas, chiefly in the wetter places.

A large part of the eastern half is covered with a young growth of Douglas-fir and other merchantable species. Other areas are covered with a fair restocking of Douglas-fir among young alder, vine maple, willows, Oregon-grape, salal, bracken, blackberry, flowering currant, dogwood, Western white pine, wild cherry, wild rose, elderberry, balm-of-Gilead, manzanita, cottonwood, yew, wild pea, cascara, red huckleberry, nettle, devilsclub, spiraea, skunkcabbage, fireweed, mockorange, Oregon maple, poison-oak, Solomonseal, snowberry, soapbush, wild hazelnut, wild honeysuckle, birch, and beargrass. Scrub oak is found near Underwood and in scattered areas along the Columbia River. Willows, cottonwood, and alders cover the sandy first bottoms. Alders cover most poorly drained areas. There is little grass except in clearings. Grasses, of which velvetgrass is the most important, are crowded out by bracken. A few areas such as Bear Prairie, where bracken and grasses have been the dominant vegetation for a long period, have developed a dark-colored surface soil.

SOILS

The soils of Skamania County have developed under a heavy stand of timber in a mild, moist climate. The parent material consists chiefly of consolidated lava rocks. Soils developed from these rocks are fine-textured and occur very extensively in the county.

Soils of the uplands along the Columbia River between Stevenson and Skamania have developed from landslide and talus material, chiefly basalt and andesite. The soils near the Lewis River have developed from the mantle of pumice that covers the lava rocks in that region. Although the Columbia River forms the southern boundary of the county, there is a limited area where the soils have developed from recent alluvial material. These soils from alluvium are subject to overflow, are sandy, and are used primarily for pasture and hay crops.

The soils of the high river terraces in the southeastern and southwestern parts of the area have been affected by material that is at least partly windblown. Some of the most productive soils in the county have developed from this material. They are usually medium-textured and have deep, permeable profiles.

The variations in climate in the county are discernible in the differences among the soils. The rainfall increases from about 50

inches in the southwestern corner to 90 inches or more in the south-central part near the crest of the Cascades and then drops rapidly to about 30 inches in the southeastern corner. In soils derived from similar material, the upper subsoil is brown to reddish brown in the southwestern part of the county, grayish brown in the central part, and reddish brown in the southeastern corner. Except in the central part of the county where the color is generally dark grayish brown, the surface soils are mostly brown to dark brown. The dark-brown surface layer is thin in well-drained forested areas. A few spots that developed under grass or open forest in the region known as Bear Prairie have deep, dark-colored surface soils.

All the soils are moderately leached. The soils near the Lewis River have developed from material containing much pumice, under an average annual rainfall of 120 inches or more. They are light-colored, coarse-textured, and highly leached down to the parent material.

The soils in Skamania County vary greatly in texture, color, drainage, and stoniness. They range from sand to clay, from gray to dark brown, from well drained to marshy, and from stony to stone free. Three broad groups based on soil texture are important in relation to crop production—medium-textured soils, fine-textured soils, and gravelly coarse-textured soils.

The medium-textured soils cover less than 5 percent of the surveyed area but account for 90 percent of the cultivated land. The fine-textured soils cover about 80 percent of the area, but only a few small plots are cultivated. The gravelly coarse-textured soils occupy about 15 percent, and a number of areas in this group are in crops.

In general, soils having a medium texture, or ranging from fine sandy loam to silt loam, are the most desirable for farming. Clay loams are by far the most extensive in the county, but only small areas are farmed because the soils are mostly shallow, stony, and mountainous.

SOIL SERIES AND THEIR RELATIONS

As shown in table 2, the soil series and miscellaneous land types of Skamania County have been placed in groups according to topographic location. The position, parent material, and drainage are given for each.

TABLE 2.—*Position, parent materials, and drainage of the soil series of Skamania County, Wash.*

SOILS OF UPLANDS

Soil series	Composition of parent materials	Drainage
Olympic	Basic igneous	Good.
Underwood	Basic igneous	Good.
St. Martin	Basic igneous	Imperfect.
Bear Prairie	Basic igneous, modified by loess	Good.
Stevenson	Landslide and talus materials from a variety of rocks, chiefly basic igneous.	Good.
St. Helens	Pumice and volcanic ash	Somewhat excessive.

TABLE 2.—*Position, parent materials, and drainage of the soil series of Skamania County, Wash.*—Continued

Soil series	Composition of parent materials	Drainage
SOILS OF OLDER TERRACES AND COLLUVIAL SLOPES		
Hesson	Fine-textured materials derived chiefly from quartzite and basalt.	Good.
Hood	Mixed medium-textured old alluvial material.	Good.
Chemawa	Weathered medium-textured pumicy loess and colluvial materials.	Good.
Cougar	Mixed gravelly glacial material	Moderately good.
SOILS OF YOUNGER TERRACES, COLLUVIAL SLOPES, AND ALLUVIAL FANS		
Felida	Mixed medium-textured materials, possibly loess.	Moderately good.
Skamania	Mixed alluvial, colluvial, and loess materials, all medium-textured.	Moderately good.
Stabler	Mixed medium-textured materials influenced by pumice.	Moderately good.
Hillsboro	Mixed sandy materials	Somewhat excessive.
Riffe	Mixed sandy materials	Somewhat excessive.
Wind River	Gravelly stream-laid materials, chiefly basic igneous.	Somewhat excessive.
Bonneville	Mixed stony and gravelly stream-laid materials.	Somewhat excessive.
Greenwater	Mixed gravelly stream-laid materials influenced by pumice.	Somewhat excessive.
Burlington	Mixed windblown sandy alluvium	Somewhat excessive.
Washougal [1]	Mixed gravelly stream-laid materials	Somewhat excessive.
Martha	Mixed medium-textured materials influenced by pumice.	Imperfect.
Nesika	Medium-textured basic igneous	Somewhat excessive.
SOILS OF ALLUVIAL FLOOD PLAINS		
Toutle	Coarse-textured mixed basaltic materials and glacial flour, influenced by pumice.	Excessive.
Columbia	Coarse- and medium-textured mixed materials.	Moderately good.
Newberg	Sandy mixed basic igneous and sedimentary materials.	Good.
Chehalis	Medium-textured mixed basic igneous and sedimentary materials.	Good.
Wapato	Fine-textured mixed basic igneous and sedimentary materials.	Poor.
ORGANIC SOIL OF UPLAND DEPRESSIONS		
Semiahmoo (muck)	Organic sedge accumulations	Very poor.

MISCELLANEOUS LAND TYPES OF UPLANDS, TERRACES, AND FLOOD PLAINS

Soil series	Composition of parent materials	Drainage
Rough mountainous land	Variable, chiefly basic igneous	Variable.
Rough broken land	Mixed gravelly materials	Variable.
Rock outcrop	Variable, chiefly basic igneous	Variable.
Lava flows	Lava rock	Variable.
Made land	Mixed materials	Variable.
Riverwash	Very coarse textured alluvium	Variable.

[1] A variant (seeped phase) soil of this series that has imperfect drainage also occurs in this county.

Soils of uplands.—The soils of this group are all of those that have developed over parent bedrock, landslide or talus materials, or pumice overlying bedrock. The parent materials were derived largely from basic igneous rock and pumice. The upland soils are mostly mountainous and are therefore not important agriculturally. Because they cover a large acreage, they are the most important group of soils for forestry.

Soils of the older terraces and colluvial slopes.—In this group are undulating to steep soils. The Chemawa soils are most important agriculturally, and the Hesson second. The Hood and Cougar soils have limited use for agriculture.

Soils of the younger terraces, colluvial slopes, and alluvial fans.—Soils of this group are less developed and have a wider range of characteristics than the soils on the older terraces and colluvial fans. They were derived mainly from alluvial or valley-filling material that is now above flood stage of the present streams. The soils have developed from medium-textured materials and are well drained. They are among the most important agricultural soils in the county. They are more strongly leached than soils of the recent alluvial flood plains but still have relatively high fertility.

The soils of this group, with those of the older terraces and colluvial slopes, make up the most important agricultural acreage in the county because they cover the largest areas that have favorable relief.

Soils of the alluvial flood plains.—These soils cover a small acreage. Some of them are very coarse-textured and droughty, but generally they are the most fertile and productive soils of the county.

Organic soils.—The organic soils are represented in this county by one soil type unit (Semiahmoo muck), which occurs in depressions in the steep uplands. Where organic soils are drained and deep enough, they are exceptionally productive. In this county, however, the deposits are too small and widely separated to be of much value for agriculture.

Miscellaneous land types.—In this group is all the nonagricultural land not accounted for in other groups. Some areas have little value, even for forestry.

SOIL TYPES, PHASES, AND MISCELLANEOUS LAND TYPES

The soils of the surveyed areas in Skamania County have been classified and mapped as 96 units representing 28 soil series and 6 miscellaneous land types. In the following pages these mapping

units are described in detail and their use and management are discussed. Their location and distribution are shown on the accompanying soil map.

The acreage and proportionate extent of the soils are given in table 3. In table 4 are average crop yields that can be expected over a period of years on the soils of the county. Farmers can learn from this table what yields they are likely to get under ordinary or common management (columns A) and good management (columns B).

TABLE 3.—*Approximate acreage and proportionate extent of the soils mapped in Skamania County, Wash.*

Soil	Acres	Percentage of county area
Bear Prairie clay loam, 2 to 5 percent slopes	357	0.2
Bear Prairie clay loam, 5 to 15 percent slopes	191	.1
Bear Prairie clay loam, 15 to 30 percent slopes	349	.2
Bonneville stony loam, 0 to 5 percent slopes	1,849	.9
Burlington fine sand, 2 to 5 percent slopes	146	.1
Burlington fine sand, 15 to 30 percent slopes	42	(1)
Chehalis silty clay loam, 0 to 3 percent slopes	365	.2
Chemawa shotty loam, 5 to 15 percent slopes	2,919	1.5
Chemawa shotty loam, 2 to 15 percent slopes	977	.5
Chemawa shotty loam, 15 to 30 percent slopes	1,952	1.0
Chemawa shotty loam, 30 to 40 percent slopes	513	.3
Columbia loam, 0 to 3 percent slopes	646	.3
Columbia fine sand, 0 to 3 percent slopes	741	.4
Columbia gravelly sand, 0 to 3 percent slopes	260	.1
Couger gravelly sandy loam, 2 to 5 percent slopes	228	.1
Felida silt loam, 5 to 15 percent slopes	667	.3
Felida silt loam, 15 to 30 percent slopes	231	.1
Felida silt loam, 30 to 40 percent slopes	78	(1)
Felida clay loam, 5 to 15 percent slopes	439	.2
Felida clay loam, 15 to 30 percent slopes	36	(1)
Felida loam, 5 to 15 percent slopes	261	.1
Greenwater gravelly sandy loam, 2 to 5 percent slopes	1,847	.9
Greenwater gravelly sand, 2 to 5 percent slopes	834	.4
Greenwater gravelly sand, 15 to 35 percent slopes	229	.1
Hesson clay loam, 5 to 15 percent slopes	804	.4
Hesson clay loam, 15 to 30 percent slopes	482	.2
Hesson clay loam, 30 to 40 percent slopes	955	.5
Hillsboro fine sandy loam, 5 to 15 percent slopes	592	.3
Hillsboro fine sandy loam, 15 to 30 percent slopes	205	.1
Hillsboro fine sandy loam, 30 to 40 percent slopes	41	(1)
Hood silt loam, 30 to 40 percent slopes	297	.2
Hood silt loam, 15 to 30 percent slopes	53	(1)
Hood silt loam, 2 to 15 percent slopes	53	(1)
Lava flows, 15 to 30 percent slopes	817	.4
Made land	12	(1)
Martha clay loam, 0 to 3 percent slopes	671	.3
Nesika gravelly loam, 2 to 5 percent slopes	715	.4
Newberg fine sandy loam, 0 to 3 percent slopes	288	.1
Olympic clay loam, 2 to 15 percent slopes	4,552	2.3
Olympic clay loam, 15 to 30 percent slopes	3,082	1.6
Olympic clay loam, 30 to 70 percent slopes	2,636	1.3
Olympic stony clay loam, 30 to 60 percent slopes	30,458	15.3
Olympic stony clay loam, 15 to 30 percent slopes	7,654	3.9
Olympic stony clay loam, 2 to 15 percent slopes	2,336	1.2
Olympic stony loam, 30 to 70 percent slopes	8,818	4.4

See footnote at end of table.

TABLE 3.—*Approximate acreage and proportionate extent of the soils mapped in Skamania County, Wash.*—Continued

Soil	Acres	Percentage of county area
Olympic stony loam, 15 to 30 percent slopes	1, 372	.7
Olympic stony loam, 2 to 15 percent slopes	605	.3
Riffe fine sandy loam, 0 to 3 percent slopes	438	.2
Riffe fine sandy loam, 3 to 15 percent slopes	69	(1)
Riverwash, 0 to 5 percent slopes	1, 368	.7
Rock outcrop, 50 to 70 percent slopes	3, 079	1.6
Rough broken land, 30 to 70 percent slopes	285	.1
Rough mountainous land, 50 to 60 percent slopes	49, 198	24.7
St. Helens pumicy sandy loam, 30 to 70 percent slopes	15, 883	8.0
St. Helens pumicy sandy loam, 15 to 30 percent slopes	1, 844	.9
St. Helens pumicy sandy loam, 2 to 15 percent slopes	311	.2
St. Martin clay loam, 30 to 40 percent slopes	1, 282	.6
St. Martin clay loam, 15 to 30 percent slopes	460	.2
St. Martin clay loam, 2 to 15 percent slopes	424	.2
St. Martin stony clay loam, 2 to 15 percent slopes	93	.1
St. Martin stony clay loam, 15 to 30 percent slopes	1, 108	.6
St. Martin stony clay loam, 30 to 50 percent slopes	5, 110	2.6
Semiahmoo muck, 0 to 2 percent slopes	3	(1)
Semiahmoo muck, shallow, 0 to 2 percent slopes	90	.1
Skamania silt loam, 2 to 15 percent slopes	687	.4
Skamania silt loam, 15 to 30 percent slopes	374	.2
Skamania silt loam, 30 to 40 percent slopes	146	.1
Skamania very fine sandy loam, 2 to 15 percent slopes	99	.1
Skamania very fine sandy loam, 15 to 30 percent slopes	43	(1)
Skamania very fine sandy loam, 30 to 40 percent slopes	24	(1)
Stabler shotty loam, 0 to 2 percent slopes	1, 633	.8
Stabler shotty loam, 2 to 6 percent slopes	2, 204	1.1
Stevenson clay loam, 2 to 15 percent slopes	1, 132	.6
Stevenson clay loam, 15 to 30 percent slopes	1, 095	.6
Stevenson stony clay loam, 30 to 40 percent slopes	4, 279	2.2
Stevenson stony clay loam, 15 to 30 percent slopes	1, 504	.8
Stevenson stony clay loam, 2 to 15 percent slopes	684	.3
Stevenson stony loam, 30 to 70 percent slopes	2, 266	1.1
Stevenson stony loam, 15 to 30 percent slopes	1, 002	.5
Stevenson stony loam, 2 to 15 percent slopes	337	.2
Stevenson soils, 15 to 50 percent slopes	1, 631	.8
Toutle sand, 0 to 3 percent slopes	1, 150	.6
Toutle gravelly sand, 0 to 3 percent slopes	105	.1
Underwood loam, 2 to 15 percent slopes	1, 462	.7
Underwood loam, 15 to 30 percent slopes	1, 249	.6
Underwood stony loam, 30 to 70 percent slopes	5, 669	2.9
Underwood stony loam, 15 to 30 percent slopes	1, 066	.5
Underwood stony loam, 2 to 15 percent slopes	607	.3
Wapato clay loam, 0 to 3 percent slopes	89	(1)
Washougal loam, 0 to 3 percent slopes	279	.1
Washougal loam, seeped, 0 to 3 percent slopes	334	.2
Wind River gravelly loam, 2 to 5 percent slopes	726	.4
Wind River gravelly loam, 15 to 30 percent slopes	23	(1)
Wind River gravelly loam, 30 to 70 percent slopes	194	.1
Wind River loam, 2 to 5 percent slopes	75	(1)
Wind River loam, 15 to 30 percent slopes	62	(1)
Water	1, 929	1.0
Total	198, 859	100.0

[1] Less than 0.1 percent.

TABLE 4.—*Estimated average acre yields of the principal crops on each soil in Skamania County, Wash.*

[Yields in columns A are obtained under ordinary managements; yields in columns B, under good management. Blank spaces indicate that the soil is unsuited to the crop or that satisfactory yield data is not available.]

Soil	Suitability for forestry	Oat hay		Timothy and clover hay		Alfalfa hay		Corn		Oats		Corn silage		Pears		Apples		Remarks
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
		Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Boxes*	*Boxes*	*Boxes*	*Boxes*	
Bear Prairie clay loam, 15 to 30 percent slopes.	Good																	Second-growth timber, brush, ferns.
Bear Prairie clay loam, 5 to 15 percent slopes.	Good	1.3	2.0	1.3	2.5			25	35	20	35							Brush pasture, scattered timber, some cultivated crops.
Bear Prairie clay loam, 2 to 5 percent slopes.	Good	1.3	2.0	1.3	2.5			25	35	20	35							Hay crops and grains.
Bonneville stony loam, 0 to 5 percent slopes.	Good																	Wooded pasture or partly cleared pasture.
Burlington fine sand, 2 to 5 percent slopes.	Good																	Pasture.
Burlington fine sand, 15 to 30 percent slopes.	Good																	Nonagricultural.
Chehalis silty clay loam, 0 to 3 percent slopes.	Excellent	2.0	2.5	2.5	3.3							10	12					Hay and pasture; wooded pasture.
Chemawa shotty loam, 15 to 30 percent slopes.	Excellent					2.5	4	30	35					400	550	350	450	Only more gently sloping parts used for crops.
Chemawa shotty loam, 5 to 15 percent slopes.	Excellent					2.5	4	30	35					400	550	350	450	Excellent orchard soil.
Chemawa shotty loam, 30 to 40 percent slopes.	Excellent																	Forestry.
Chemawa shotty loam, 2 to 5 percent slopes.	Excellent					2.5	4	30	35					400	550	350	450	Excellent orchard soil.
Columbia fine sand, 0 to 3 percent slopes.	Fair			1.5	2.0													Wooded pasture.
Columbia gravelly sand, 0 to 3 percent slopes.	Poor																	Wooded pasture.
Columbia loam, 0 to 3 percent slopes.	Fair	[1]3.0	[1]4.0	2.5	3.0	2.5	5	35	45	35	50							Best native pasture in area surveyed.
Cougar gravelly sandy loam, 2 to 5 percent slopes.	Good																	More valuable for timber than for farming.
Felida clay loam, 15 to 30 percent slopes.	Excellent																	Forestry.
Felida clay loam, 5 to 15 percent slopes.	Excellent	1.8	2.0	2.0						40		10						General farming; slight erosion hazard.
Felida loam, 5 to 15 percent slopes.	Excellent	2.0	2.5	2.5	3.0	3.0	5	42		42		10	12					General farming.

[1] Oats and vetch.

TABLE 4.—*Estimated average acre yields of the principal crops on each soil in Skamania County, Wash.*—Continued

Soil	Suitability or forestry	Oat hay		Timothy and clover hay		Alfalfa hay		Corn		Oats		Corn silage		Pears		Apples		Remarks
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
		Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Boxes*	*Boxes*	*Boxes*	*Boxes*	
Felida silt loam, 5 to 15 percent slopes.	Excellent	2.0	2.5	2.3	-----	3.0	5	40	-----	40	-----	10	12	-----	-----	-----	-----	General farming.
Felida silt loam, 15 to 30 percent slopes.	Excellent	2.0	2.8	2.5	-----	-----	6	40	-----	40	-----	12	-----	-----	-----	-----	-----	Wooded pasture.
Felida silt loam, 30 to 40 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forestry.
Greenwater gravelly sand, 2 to 5 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Nonagricultural.
Greenwater gravelly sand, 15 to 35 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Nonagricultural.
Greenwater gravelly sandy loam, 2 to 5 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Nonagricultural.
Hesson clay loam, 15 to 30 percent slopes.	Very good	1.5	-----	1.8	2.5	-----	-----	35	-----	30	-----	8	-----	-----	-----	-----	-----	About half in crops; erosion control necessary.
Hesson clay loam, 5 to 15 percent slopes.	Very good	1.5	-----	1.8	2.8	-----	-----	35	-----	30	-----	8	-----	-----	-----	-----	-----	Mostly in hay, corn, and prunes.
Hesson clay loam, 30 to 40 percent slopes.	Very good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forestry.
Hillsboro fine sandy loam, 15 to 30 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Wooded pasture or in brush.
Hillsboro fine sandy loam, 5 to 15 percent slopes.	Excellent	2.0	2.5	2.3	-----	-----	-----	40	45	35	-----	10	-----	-----	-----	-----	-----	Good for fruit, nuts, and nursery stock.
Hillsboro fine sandy loam, 30 to 40 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forestry.
Hood silt loam, 15 to 30 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	In forest; would be productive for crops.
Hood silt loam, 2 to 15 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	In forest; would be productive for crops.
Hood silt loam, 30 to 40 percent slopes.	Excellent	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Small fruits, vegetables, and hay crops yield well if irrigated.
Lava flows, 15 to 30 percent slopes	Poor	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Nonagricultural; may be used for building roads.
Made land	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Nonagricultural.
Martha clay loam, 0 to 3 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Wooded pasture.
Nesika gravelly loam, 2 to 5 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Wooded pasture.
Newberg fine sandy loam, 0 to 3 percent slopes.	Very good	2.0	-----	2.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Limited area; wooded pasture.

Olympic clay loam, 15 to 30 percent slopes.	Very good																	Forestry; not cultivated.
Olympic clay loam, 2 to 15 percent slopes.	Very good	1.0	2	1.3	2.5					20								Second-growth forests; small acreage in hay, grain, pasture, fruit.
Olympic clay loam, 30 to 70 percent slopes.	Very good																	Forestry; not cultivated.
Olympic stony clay loam, 15 to 30 percent slopes.	Very good																	Forestry; not cultivated.
Olympic stony clay loam, 2 to 15 percent slopes.	Very good																	Forestry; not cultivated.
Olympic stony clay loam, 30 to 60 percent slopes.	Very good																	Forestry; not cultivated.
Olympic stony loam, 15 to 30 percent slopes.	Very good																	Forestry; not cultivated.
Olympic stony loam, 2 to 15 percent slopes.	Very good																	Forestry; not cultivated.
Olympic stony loam, 30 to 70 percent slopes.	Very good																	Forestry; not cultivated.
Riffe fine sandy loam, 3 to 15 percent slopes.	Excellent																	Forest and wooded pasture.
Riffe fine sandy loam, 0 to 3 percent slopes.	Excellent	1.5	2	1.5	2.3					28								Young forest; small acreage in orchards, truck crops, general farm crops.
Riverwash, 0 to 5 percent slopes	Very poor																	Little or no vegetation.
Rock outcrop, 50 to 70 percent slopes	Very poor																	Same.
Rough broken land, 30 to 70 percent slopes.	Fair																	Forests.
Rough mountainous land, 50 to 60 percent slopes.	Fair to poor																	Forests.
St. Helens pumicy sandy loam, 15 to 30 percent slopes.	Very good																	Forest.
St. Helens pumicy sandy loam, 2 to 15 percent slopes.	Very good																	Forest.
St. Helens pumicy sandy loam, 30 to 70 percent slopes.	Very good																	Forest.
St. Martin clay loam, 15 to 30 percent slopes.	Good																	Forest.
St. Martin clay loam, 2 to 15 percent slopes.	Good																	Forestry; some pasture.
St. Martin clay loam, 30 to 40 percent slopes.	Good																	Forest.
St. Martin clay loam, 15 to 30 percent slopes.	Good																	Forest.
St. Martin stony clay loam, 2 to 15 percent slopes.	Good																	Forest; wooded pasture.
St. Martin stony clay loam, 30 to 50 percent slopes.	Good																	Forest.
Semiahmoo muck, 0 to 2 percent slopes.	Poor																	Areas too small and too isolated for profitable cultivation; covered with marshy growth.
Semiahmoo muck, shallow, 0 to 2 percent slopes.	Poor																	Same.

TABLE 4.—*Estimated average acre yields of the principal crops on each soil in Skamania County, Wash.*—Continued

Soil	Suitability for forestry	Oat hay		Timothy and clover hay		Alfalfa hay		Corn		Oats		Corn silage		Pears		Apples		Remarks
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Skamania silt loam, 15 to 30 percent slopes.	Excellent																	Forest.
Skamania silt loam, 2 to 15 percent slopes.	Excellent	1.5		1.5						25								Fruits and nuts do well.
Skamania silt loam, 30 to 40 percent slopes.	Excellent																	Forest.
Skamania very fine sandy loam, 15 to 30 percent slopes.	Excellent	1.3		1.3														Some pasture and hay crops.
Skamania very fine sandy loam, 2 to 15 percent slopes.	Excellent	1.8		1.8				30		30								Small fruits and vegetables.
Skamania very fine sandy loam, 30 to 40 percent slopes.	Excellent																	Forestry only.
Stabler shotty loam, 0 to 2 percent slopes.	Very good	1.5		1.5														Pasture and hay crops.
Stabler shotty loam, 2 to 6 percent slopes.	Very good																	Forest.
Stevenson clay loam, 15 to 30 percent slopes.	Very good	1.3		1.3						25								Partly cleared pasture.
Stevenson clay loam, 2 to 15 percent slopes.	Very good	1.5		1.5						25								Pasture and hay crops.
Stevenson soils, 15 to 50 percent slopes.	Fair																	Nonagricultural: forest.
Stevenson stony clay loam, 15 to 30 percent slopes.	Very good																	Nonagricultural; forest.
Stevenson stony clay loam, 2 to 15 percent slopes.	Very good			1.5						25								Very stony; partly cleared pasture.
Stevenson stony clay loam, 30 to 40 percent slopes.	Very good																	Nonagricultural; forest.
Stevenson stony loam, 15 to 30 percent slopes.	Good																	Nonagricultural; forest.
Stevenson stony loam, 2 to 15 percent slopes.	Good																	Nonagricultural; forest.
Stevenson stony loam, 30 to 70 percent slopes.	Good																	Nonagricultural; forest.
Toutle gravelly sand, 0 to 3 percent slopes.	Fair																	Nonagricultural; forest.
Toutle sand, 0 to 3 percent slopes	Good																	Nonagricultural; forest.
Underwood loam, 15 to 30 percent slopes.	Very good																	Some pasture; forest.

Underwood loam, 2 to 15 percent slopes.	Very good	1.5	-----	1.3	-----	2	3	-----	-----	30	-----	-----	-----	-----	-----	-----	-----	Some fruit and nut orchars;d hay and pasture; forest.
Underwood stony loam, 15 to 30 percent slopes.	Very good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forestry only.
Underwood stony loam, 2 to 15 percent slopes.	Very good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forest; small acreage in partly cleared pasture.
Underwood stony loam, 30 to 70 percent slopes.	Very good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forestry only.
Wapato clay loam, 0 to 3 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Wooded pasture; hay and pasture crops when drained.
Washougal loam, 0 to 3 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Pasture.
Washougal loam, seeped, 0 to 3 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Pasture.
Wind River gravelly loam, 2 to 5 percent slopes.	Good	1.5	-----	1.8	-----	-----	-----	-----	-----	30	-----	-----	-----	-----	-----	-----	-----	Hay, fruit, and truck crops; wooded pasture; forest.
Wind River gravelly loam, 15 to 30 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	None cultivated; forestry.
Wind River gravelly loam, 30 to 70 percent slopes.	Good	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Forest; commercial gravel and sand.
Wind River loam, 2 to 5 percent slopes.	Good	1.5	-----	1.8	-----	-----	-----	-----	-----	30	-----	-----	-----	-----	-----	-----	-----	Pasture; hay crops; fruits.
Wind River loam, 15 to 30 percent slopes.	Good	1.5	-----	1.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Pasture; hay crops; forest.

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Bear Prairie clay loam, 2 to 5 percent slopes (Bc).—This soil has developed under grass, ferns, and scattered Douglas-fir. It occurs on high benchlike areas in the uplands in association with Olympic soils. The parent material consists of highly weathered basalt, partly modified by loess and old alluvial material. In places the surface soil has been definitely modified by old transported material similar to Felida soil material. Drainage is good.

The 12-inch surface soil is dark grayish-brown clay loam that is nearly black when moist. It contains a small quantity of relatively soft shot that have rust-colored centers and it has a medium granular structure. In virgin areas it is rootbound by grass, ferns, and shrubs. The organic matter content is high. The surface soil grades into a slightly lighter grayish-brown clay loam or heavy silt loam having a weak granular structure, many roots, and a fairly high organic-matter content. At about 24 inches there is a sharp transition to brown clay loam or heavy silt loam that breaks into fine subangular blocks that are fairly easy to pulverize. Many dark streaks are along old holes left by burrowing animals and along decayed roots. At about 32 inches the material is yellowish-brown clay loam that has a few fine dark streaks along old roots and that breaks into fine subangular blocks having a glossy surface along their cleavage planes. This layer, like the layers above, may contain a few angular rocks.

At an average depth of 60 inches, the material is light yellowish-brown silty clay loam containing some fine roots and many angular basalt rocks and rock fragments. The quantity of rock increases with depth. The soil is strongly acid throughout the profile.

Use and management.—As the cost of clearing is small compared with that for heavily forested soils, about 75 percent of this soil is in cultivation. Of the cultivated areas, about 25 percent is planted to oats for oat hay or grain, 50 percent is kept in clover and timothy for hay and pasture, and 25 percent is planted to corn and other crops. The uncultivated areas are of little value for pasture because the rank stand of ferns crowds out the grasses.

This soil is highly leached and only moderately fertile, although it has a good structure and looks highly productive. Experiments show that nitrogen and phosphorus applied in combination produce the biggest increase in yields. Lime and a complete fertilizer may increase yields, but probably not enough to justify the extra cost.

Bear Prairie clay loam, 5 to 15 percent slopes (Bb).—Greater slope and more variation in subsoil texture—silt loam to heavy clay loam—distinguish this soil from Bear Prairie clay loam, 2 to 5 percent slopes. The depth to the rocky substratum is 3 to 10 feet. Surface drainage is slightly more rapid than on less sloping areas of Bear Prairie clay loams. This soil is not extensive but is closely associated with the other Bear Prairie soils.

The native vegetation is similar to that on Bear Prairie clay loam, 2 to 5 percent slopes, and use and management of the two soils are the same. Less than 25 percent is in cultivation; the rest is in scattered timber, brush, ferns, and brush-and-fern pasture.

Bear Prairie clay loam, 15 to 30 percent slopes (Ba).—This soil occurs in scattered areas in association with Bear Prairie clay loam, 5 to 15 percent slopes, and is largely covered with ferns, second-growth timber, brush, and stumps. Most cleared areas border cultivated less

sloping areas. The profile is similar to that of Bear Prairie clay loam, 5 to 15 percent slopes, but it varies in depth to the stony clay loam substratum and in places is fairly shallow. On the stronger slopes the profile has the characteristics of stony colluvial material. The soil is considered more valuable for growing timber than farming. Less than 40 acres is cultivated.

Bonneville stony loam, 0 to 5 percent slopes (Bd).—This dark-colored soil occurs on isolated gravelly or stony stream-laid terraces not reached by normal overflow but usually less than 50 feet above the present flood plain. The soil is nearly level to gently undulating and in places distinctly hummocky or pitted. Drainage is somewhat excessive, but after heavy rains water may stand for a short time in depressions.

The soil was derived from stony and gravelly alluvial deposits laid down upon an older flood plain of the Columbia and Washougal Rivers. In places it has been modified by recent coarse-textured alluvial fan deposits left by swift-flowing mountain streams. The parent material comes largely from basalt and andesite but is more recent and mixed than that of the Wind River soils. The wide variation in the size of gravel and stones and the presence ot boulders up to 4 feet in diameter indicate that the alluvial deposits were laid down by swift and turbulent waters. The dark color of the surface soil may be partly attributed to the fact that the areas along the Columbia River were kept denuded of forests by the Indians so they could use them for campsites.

This soil is very closely associated with Washougal soils but is much shallower and stonier and nonagricultural. Washougal soils make fair cropland when cleared.

The present vegetation consists mainly of a young stand of Douglas-fir, some alder, prairie oak, dogwood, mockorange, vine maple, balm-of-Gilead, willow, cedar, and Oregon-grape.

Virgin areas of this Bonneville soil are covered with a layer of moss, loose leaves, dead grass, ferns, and other litter that is underlain by a film of dark-brown leaf mold. This layer is irregular; it is usually about ¾ inch thick but it varies from ½ to 2 inches in thickness. More moss is found on the Bonneville soil than on other soils in the region.

The surface soil below the organic layer is a dark grayish-brown stony loam containing considerable organic material. When moist it is nearly black. A few shot concretions are in this layer, and scattered over the surface are many rounded or subangular boulders, chiefly of basalt. The surface soil is medium to strongly acid and gritty and friable when moist but slightly plastic when wet. This layer is usually 3 or 4 inches deep but it varies from 2 to 8 inches.

The surface soil is abruptly replaced by dark-gray or grayish-brown gravelly loam that consists of an assortment of angular and rounded pieces of gravel, stones, and fine interstitial material that is usually slightly cemented. Some of the gravel and stones are partly weathered. With depth the soil becomes coarser and more yellowish, the color being somewhat variegated.

Between 8 and 20 inches (usually at 14) are grayish-brown to olive-gray gravel, sand, and boulders. Most of the boulders are of basalt and are about 6 inches in diameter, but boulders up to 4 feet in diameter may occur on the surface or anywhere in the profile.

An area 5 miles north of Underwood on a terrace along the White Salmon River differs from the typical soil in having a brown surface color to a depth of about 8 inches and in being underlain by a light yellowish-brown gravelly loam that contains considerable rock. Below 18 inches gray to yellowish-brown gravelly loam occurs in spaces between the rocks. The rocks are 4- to 6-inch rounded and subangular basalt boulders. As there is little organic material on the surface, this soil is lighter colored than the typical areas of Bonneville stony loam. On Rock Creek about 6 miles northwest of Stevenson is another area of Bonneville stony loam that has lighter colored surface soil.

Use and management.—Much of Bonneville stony loam, 0 to 5 percent slopes, is now in wooded pasture. Only a few small pastures are cleared. The soil is of low agricultural value because of the stony substratum and the rocks on the surface. The relief makes the locality ideal for industrial sites, however, and some areas near the Columbia River may be used eventually for that purpose.

Burlington fine sand, 2 to 5 percent slopes (Be).—This soil occurs on gently undulating terracelike areas adjacent to the Columbia River. It consists of loose sandy material blown from alluvial deposits along the river and reworked by the wind. Drainage is somewhat excessive except during short periods of extremely high water. Owing to its loose coarse texture, however, the soil has low water-holding capacity. It lies between the Hillsboro soils which occupy slightly higher terraces to the north and the Columbia soils, which occupy lower positions adjacent to the river. The native vegetation consists of a sparse growth of Douglas-fir and alder.

The 10-inch surface soil is loamy fine sand, grayish brown when dry and slightly darker when moist. In uncleared areas it is bound with fine roots. This layer grades into a yellowish-brown fine sand that contains a small quantity of mica, is loose and incoherent when dry, and very friable when moist.

Between 26 and 90 inches the soil is pale yellowish-brown fine sand containing some mica. This material is loose and single grained. Practically no rock and gravel are in the profile. The reaction is strongly acid.

Use and management.—Loose sandy texture limits use of this soil to hay and pasture. About half the area is cleared and so used. When irrigated and heavily fertilized, this soil can be planted to small fruits and vegetables. Uncultivated areas are in timber and stump pasture.

Burlington fine sand, 15 to 30 percent slopes (Bf).—Stronger relief is the chief difference between this soil and Burlington fine sand, 2 to 5 percent slopes. The parent material is windblown fine sand deposited on the steep slopes of Wind Mountain. The depth to the underlying basaltic materials ranges from 2 to 10 feet. This soil is not extensive and is best suited to timber. None of it is cultivated.

Chehalis silty clay loam, 0 to 3 percent slopes (Ca).—This brown recent alluvial soil is fairly high in organic matter, well drained, and very productive for most crops. It occupies nearly level bottom lands that overflow during very high water. It is not so well drained as most Chehalis soils in other areas but is better drained than Wapato soils. Small scattered areas occur along the Columbia River. The

native vegetation consists of alder, maple, willow, some Douglas-fir, spirea, devilsclub, skunkcabbage, ferns, and other shrubs and forbs.

The 15-inch surface soil is brown to dark-brown silty clay loam. It is friable and has a strong granular structure. The upper subsoil between 15 and 36 inches is brown clay loam or silty clay loam that breaks into weak fine subangular blocky aggregates. From 36 to 60 inches is a strong-brown silty clay loam containing a trace of rust-brown mottling. Below 60 inches lies the substratum, yellowish brown stratified layers of loamy sand, loam, and gravelly loam. The depth to the coarse-textured substratum varies from 36 to more than 72 inches. The gravelly substratum is not typical of Chehalis soils. Fine roots penetrate this soil to depths of 72 inches or more.

Included with this soil are small areas that have grayish-brown clay loam to silty clay surface soil and a dark-brown heavy clay loam subsoil. These included soils overlie a yellowish-brown heavy clay loam that contains a trace of rust-brown and grayish-brown mottling.

Use and management.—A small acreage is used for hay and pasture and the rest is in wooded pasture and timber.

Chemawa shotty loam, 5 to 15 percent slopes (Cc).—This is the most extensive cultivated soil in the county. It occupies long colluvial-like slopes and sloping benchlike areas on high terraces above the Columbia River. The rolling colluvial slopes merge with the sloping terraces at lower elevations.

Like other Chemawa soils, this soil occurs only in the southeastern part of the county, mainly between the White Salmon and Little White Salmon Rivers. It is adjacent to the Underwood soils but generally is not mingled with them.

The profile is extremely shotty, yellowish brown, homogeneous, deep, and friable. The parent material appears to be pumicy volcanic ash that has been carried down from higher elevations and deposited as colluvium and alluvium. The materials are thoroughly disintegrated and decomposed and give little evidence of the nature of the original rock. Many small pumice particles in the lower part of the profile indicate that the material is decomposed volcanic ash, which leads to the conclusion that it was erupted from Mount St. Helen, a volcanic peak.

Drainage is good, and the water-holding capacity is high. The native vegetation consists mostly of Douglas-fir, some cedar, hemlock, alder, maple, and willows, a few western yellow pine, prairie oak, dogwood, wild cherry, manzanita, Oregon-grape, blackberry, ferns, soapbush, and a small quantity of grass, other trees, shrubs, and flowering plants. The large trees have been cut, but most of the uncleared areas are thickly covered with second-growth Douglas-fir and alder.

Virgin areas are covered with about 1½ inches of organic material—loose fir needles, leaves, moss, twigs, and bark on the surface and dark-brown fairly well decomposed leaf mold containing some mineral soil in the lower part. Many white mycelia from molds are present. The organic material passes sharply to a brown loam that has an average shot content of about 30 percent. When the shot is removed, the soil feels smooth and silty. Individual pieces of shot (1/10 to ¼ inch in diameter) are yellowish brown on the outside and reddish brown on the inside. A few can be crushed between the fingers, but most are hard to cut with a knife. The organic content of this layer is moderate to high, and it is slightly acid.

The upper 6 inches is underlain by yellowish-brown shotty loam of friable granular structure. At 15 to 18 inches this shotty loam grades into yellowish-brown, slightly acid to medium acid, heavy loam or silt loam that contains less shot and stands firmly in a cut bank but breaks into fine blocks that pulverize easily.

Between 40 and 70 inches the soil is yellowish-brown to brownish-yellow friable silt loam that breaks into angular blocks. These blocks break into finer blocks. The reaction is slightly to medium acid. A few small roots extend to about 70 inches.

Shot occurs throughout the profile but decreases with depth. The soil is free from rock and gravel. Except for small variations in compaction and the decrease in amount of shot with depth, the material below the surface soil is very uniform in color, texture, and structure.

The parent material below 70 inches is pale yellowish-brown or brownish-yellow silt loam similar to the subsoil in consistence. In most places the substratum apparently extends to 15 to 20 feet or more, where it is underlain by yellowish-brown to reddish-brown clay loam and lava rock. This rock substratum is closer to the surface in areas bordering Underwood soils.

Use and management.—This is the most important agricultural soil in the county from the standpoint of acreage. Owing to lack of sufficient moisture during summer, small grains and hay crops do not produce so well as on other soils of similar texture on the terraces in the western part of the county. This soil, however, is one of the most productive for deep-rooted crops and orchards. Because it is deep and friable, it is well suited to fruits, especially apples and pears (pl. 1, *A*). Of the 30 to 40 percent of the soil in cultivation, approximately half is planted to these fruits.

The Anjou variety of pears is most common, followed by Bartlett and some Bosc. Yellow Newton is the most popular apple variety on this soil. Others are Esopus Spitzenberg, Delicious, and Ortley. The fruit is of good quality. Most growers use about 5 or 6 pounds of ammonium sulfate to the tree, as well as some ammonium phosphate and other commercial fertilizer. A cover crop of rye and vetch is planted in fall and disked into the ground late in spring. The fruit is grown without irrigation. Small areas are planted to cherries, peaches, strawberries, and other fruits.

Alfalfa and corn do well, but the dry summers limit yields of clover, timothy, and oats.

This soil is not easily eroded because it absorbs water readily. In some winters, however, when the ground is frozen for a short time, runoff may be considerable for short periods. Fields should be plowed only along the contours, and orchards kept in cover crops during winter. Erosion is negligible on the uncleared areas.

The uncleared areas are largely in basinlike places that have poor air drainage and consequently are unsuitable for the production of fruit. These areas, however, are suitable for alfalfa and other crops and probably will be cleared in the near future.

Chemawa shotty loam, 2 to 5 percent slopes (Ce).—This soil occurs mainly as one large area on a high, nearly level bench along the Little White Salmon River. Except for its more gentle slopes, it is similar to Chemawa shotty loam, 5 to 15 percent slopes. Drainage

is good, and the water-holding capacity is high. Only a few acres are cultivated. Most areas have a good stand of second-growth timber, largely Douglas-fir.

Chemawa shotty loam, 15 to 30 percent slopes (Cb).—In profile and other features, this soil is similar to Chemawa shotty loam, 5 to 15 percent slopes. It occurs on smooth and uniform but fairly strong slopes at the foot of low mountains. The relief is constructional and shows little erosion.

Use and management.—About 20 percent of this soil has been cleared and is largely used for apple and pear orchards. Areas south of Underwood Mountain are especially favorable for fruits because they have good air drainage. In other places more or it is used for pasture and hay crops, and yields are similar to those on Chemawa shotty loam, 5 to 15 percent slopes.

Owing to the hilliness, cultivated areas need to be carefully protected against erosion. Cultivation should be on the contour, and stronger slopes should be terraced. More than 25 percent of the surface soil has been eroded from small areas, although little of this soil has been cultivated for many years.

Chemawa shotty loam, 30 to 40 percent slopes (Cd).—Compared with other Chemawa soils, this soil has a shallower and more variable mantle of silt over rock. The deposit or silt ranges from 2 to more than 10 feet in thickness. This soil occurs on steep slopes along V-shaped ravines and generally borders the Underwood soils.

Most areas are covered with a young stand of trees and brush. A very small acreage is cultivated. This soil should not be cleared, as erosion would be very difficult to control on such steep slopes. It is more valuable for timber.

Columbia loam, 0 to 3 percent slopes (Ch).—This alluvial soil occupies river flood plains and low terraces in close association with Columbia fine sand, 0 to 3 percent slopes. It is subject to overflow during rainy winter months and when the Columbia River is at flood stage. The topography ranges from level to hummocky. Many areas of the soil are in lower depressions and lagoons. The alluvial material is of mixed origin but came largely from lava rocks and granite.

This soil differs from the Puyallup soils—not mapped in this county but found elsewhere in the State—in mica content and in having a more heterogeneous parent material. Much of the parent material has been transported great distances, mainly from the headwaters of the Columbia River.

Surface drainage is moderately good except during heavy rains in winter. The vegetation is a mixed growth of hardwoods, cottonwoods, willows, and native grasses.

The 6-inch surface soil is weakly granular grayish-brown to olive-gray loam. This layer is generally slightly acid in areas along the Columbia River but medium acid elsewhere. Its texture is variable—fine in the hollows and coarser on slight elevations. The upper subsoil, between 7 and 24 inches, is olive-gray loam containing some mica. It is platy and crumbles easily. Below 24 inches the material is distinctly stratified and includes layers of olive-gray and gray micaceous fine sand, loam, sandy loam, and gravel. A sandy sub-

stratum is characteristic of the soil. Some fine rust-brown mottling is found in the finer textured layers of the substratum. Roots extend to depths of more than 6 feet.

Use and management.—The periodic high water table and the flooding during winter limit use of this soil mainly to wooded pasture. It produces about the best native pasture in the area. Many tracts have been partly cleared to improve the pasture. About 10 percent of the soil is cleared for hay and pasture.

Mixed clover and timothy and oats and vetch are the chief hay crops. Alfalfa drowns out easily because of the frequent flooding and the high water table. Some subirrigation helps to carry crops through dry months in summer.

Columbia fine sand, 0 to 3 percent slopes (Cf).—This soil differs from the closely associated Columbia loam mainly in having a coarser textured and shallower surface soil. The soil is nearly level but somewhat hummocky in places. Surface drainage is very slow; the small depressions are covered with water during winter rains. Internal drainage is very rapid except during periods of high water. Small low dunelike areas of sand blown up from the shore of the Columbia River are included in mapping. The surface layer is about 6 inches of light olive-gray to gray fine sand. The upper part of this layer is slightly darker colored. The texture is coarser near the streams and finer away from them. The organic content is low. A loose light olive-gray and gray micaceous fine sand underlies the surface layer. This material becomes grayer with depth; otherwise, there is little change to a depth of 60 inches.

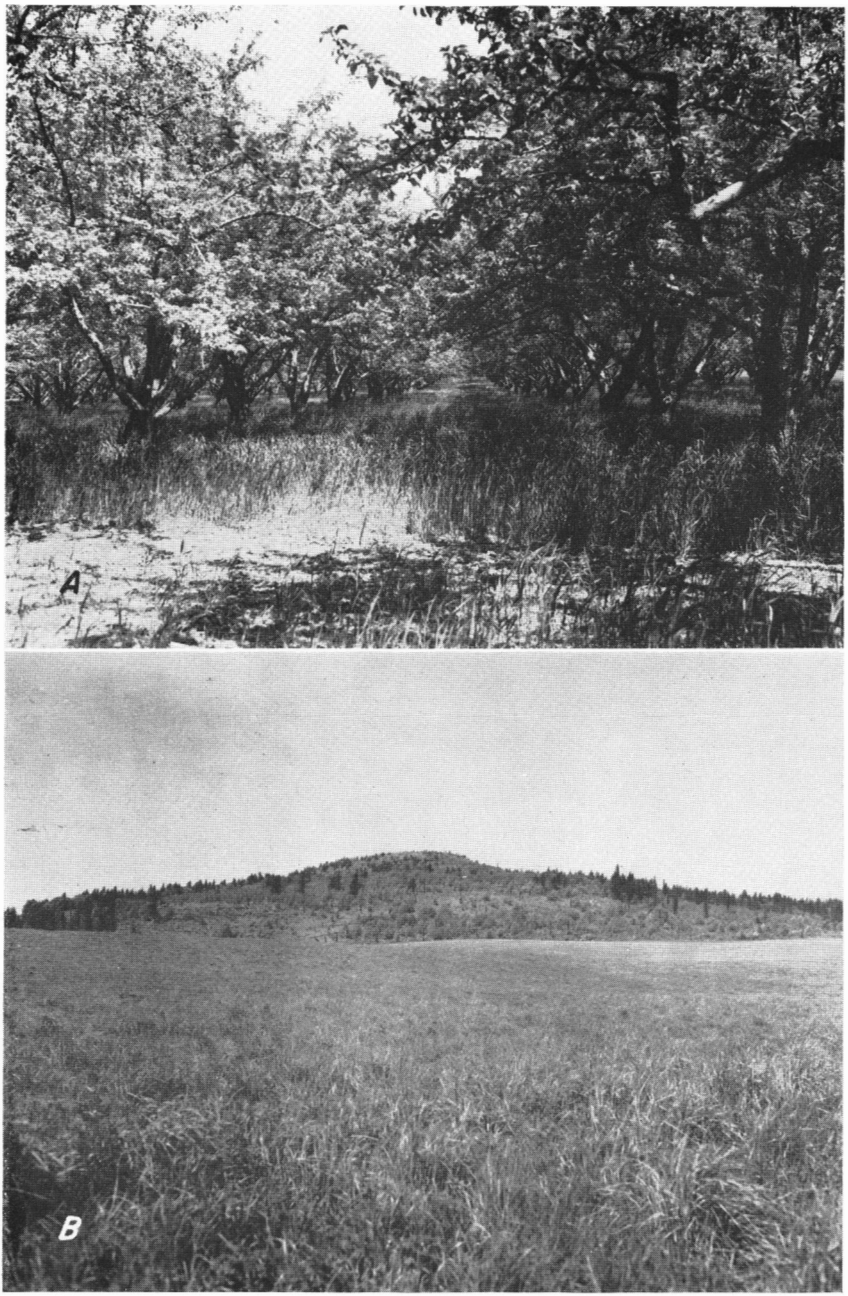
The entire profile is free from gravel and rock. The substratum is distinctly stratified. Layers of sandy loam, loam, and in places thin seams of gravel may be found in it at any depth. The profile is loose and porous when dry and slightly firm when moist. It ranges from neutral to medium acid. Fine roots penetrate 60 inches or more.

Use and management.—As for Columbia loam, 0 to 3 percent slopes, most of this fine sand is used for wooded pasture. About 20 percent is cleared for pasture and hay crops. Because it is loose and porous, the soil is droughty during summer. Some areas have very scant vegetation because they have been covered recently by deposits from the Columbia River.

Columbia gravelly sand, 0 to 3 percent slopes (Cg).—This soil differs from Columbia fine sand in that it contains gravel and occupies areas closer to streams. It was derived from a recent coarse-textured material deposited over Bonneville soil material. The small scattered areas occur on first bottoms of the smaller streams. The soil is subject to overflow during high water. An area near North Bonneville, however, occupies a higher terrace than typical.

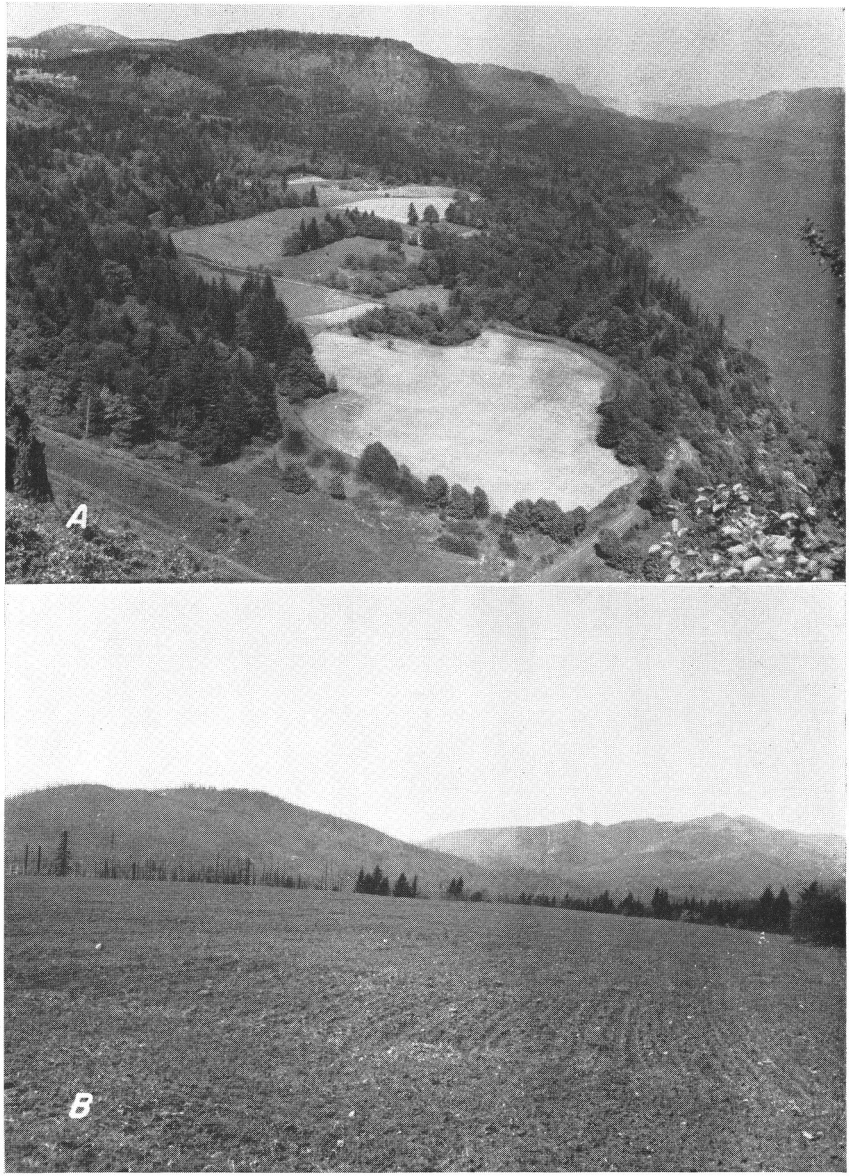
In most places a thin layer of loose leaves and organic material covers the surface. Below this layer lies about 10 inches of olive-gray to gray gravelly sand. The texture, however, is extremely variable. The 10-inch layer may have areas of sand, fine sand, and loamy gravel. Between depths of 10 and 60 inches are gray and olive-gray stratified layers of sand and gravel and some waterworn rock.

The soil is covered with alder, a few Douglas-fir, cedar, maple, bracken, blackberry, and other trees and shrubs. None of it is cultivated, but some areas are used for summer homesites. It is best used for timber and recreational purposes.

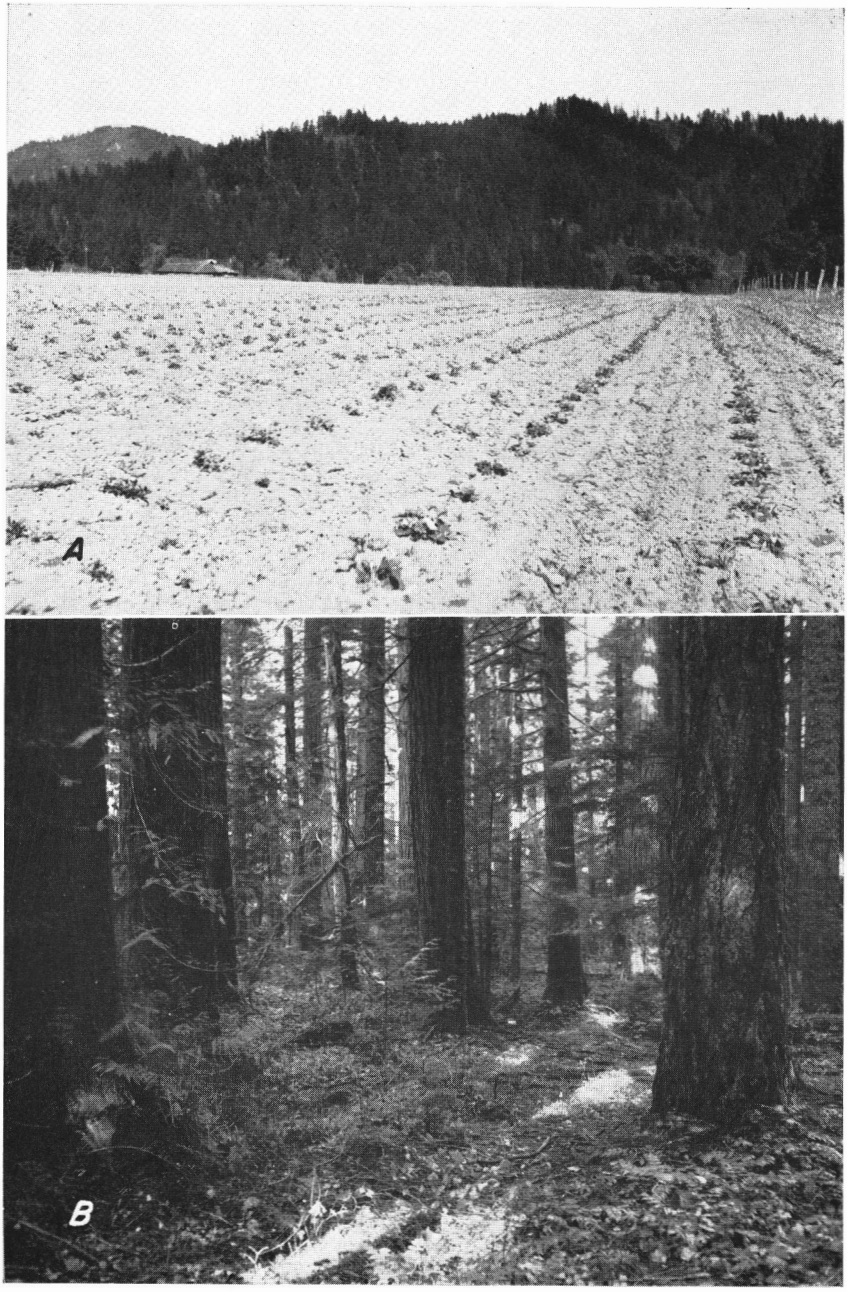


A, Apple orchard and cover crop of rye on Chemawa shotty loam, 5 to 15 percent slopes.

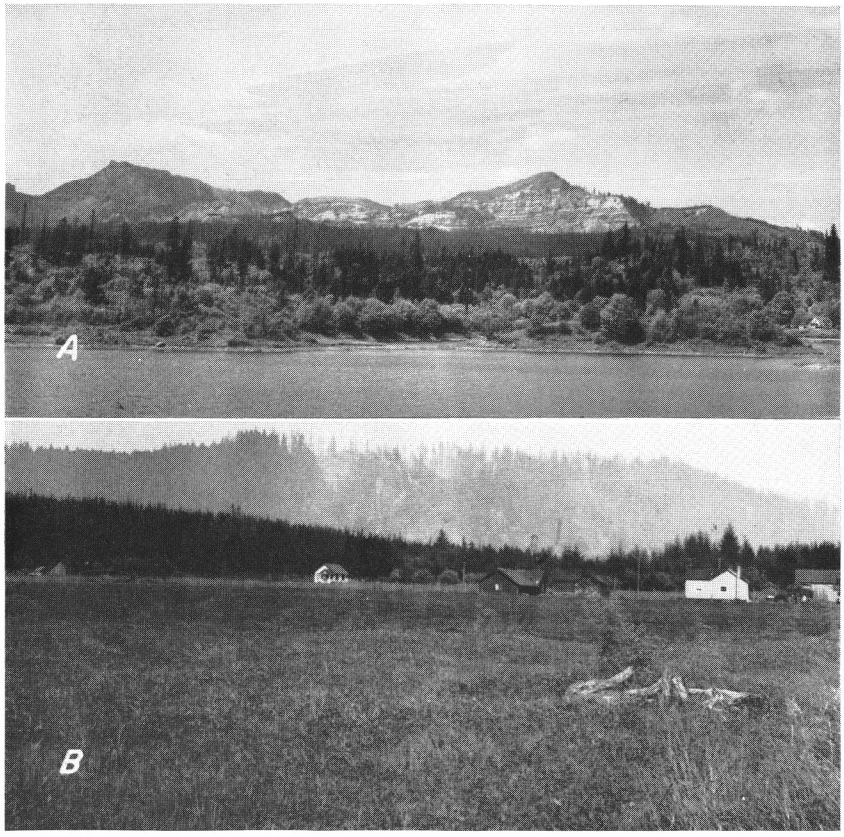
B, Mixed grass and red clover for hay on Felida loam, 5 to 15 percent slopes; cutover Olympic clay loam soils on hills in background.



A, Cleared and farmed Hillsboro soils on terraces above the Columbia River; mostly Olympic soils on the rough stony uplands.
B, Cleared area of Olympic clay loam, 2 to 15 percent slopes; Olympic stony clay loam, 30 to 60 percent slopes, in background.



A, Young strawberry plants on Riffe fine sandy loam, 0 to 3 percent slopes; forested Olympic soils in background.
B, Virgin forest of Douglas-fir on Stabler shotty loam, 0 to 2 percent slopes.



A, Stevenson soils in foreground and Rough mountainous land, 50 to 60 percent slopes, in background.
B, Red clover on Wind River loam, 2 to 5 percent slopes.

Cougar gravelly sandy loam, 2 to 5 percent slopes (Ck).—This soil is associated with Greenwater gravelly sandy loam, 2 to 5 percent slopes. Unlike that soil, however, it was derived from glacial material and has a cemented layer several feet thick beginning at a depth of about 12 inches. Owing to the hardpan, internal drainage is restricted.

In timber, this Cougar soil is covered with about 2 inches of brown forest litter that grades into dark-brown well-decomposed leaf mold. This organic material is underlain by 1 or 2 inches of ashy-gray gravelly sandy loam. The gray layer varies considerably in thickness within short distances and is most conspicuous when dry. Between 4 and 12 inches is grayish-brown very friable gravelly sandy loam that is abruptly replaced by a light-gray, cemented, gravelly sandy loam hardpan. The hardpan usually extends to about 42 inches, but it varies in depth and reaches 72 inches in places. The hardpan, difficult to penetrate with a crowbar and almost impossible to dig out with a shovel, contains many waterworn cobble-sized rocks, largely andesite and basalt. A mat of fine roots is on the surface of the hardpan, but few roots penetrate it. Moisture penetrates very slowly. The hardpan is underlain by olive-gray to light grayish-brown stratified layers of sand, gravel, gravelly sandy loam, and waterworn boulders. The entire profile is strongly acid.

Use and management.—A few acres of this unproductive soil are used for hay and pasture. Probably this land is of more value for timber than for farming.

Felida silt loam, 5 to 15 percent slopes (Fd).—This soil occurs in the extreme southwestern part of the county on gently rolling terrace-like areas and colluvial slopes at the foot of low mountains. It occupies elevated, eroded terraces that are cut by the steep valleys along minor drainageways. It is much less extensive than the Felida soils in Clark County to the west. The soil was derived from alluvial deposits laid down upon an old flood plain of the Columbia River. In places the parent material appears to have been modified by wind and to have come from many kinds of rocks. The terraces occupied by this and the other Felida soils are now several hundred feet above the Columbia River and are moderately well drained.

The native vegetation on this Felida soil was a heavy growth of Douglas-fir and a few cedars, hemlocks, alders, and other trees and shrubs. Most of the virgin timber has been cut.

The 10-inch grayish-brown to brown friable silt loam surface soil contains many shot. The structure is medium granular. The upper part of the layer is slightly darker when moist. The $\frac{1}{10}$- to $\frac{1}{4}$-inch shot are fairly hard to cut with a knife and are brown on the outside and reddish brown in the center. Between 10 and 18 inches is brown silt loam containing a few shot. This layer has a slightly finer silt loam texture than the surface soil and breaks to fine subangular blocky aggregates that crumble easily. Below 18 inches there is an abrupt change to yellowish-brown silty clay loam or heavy silt loam. The blocky aggregates in this layer are hard when dry, friable when moist, and slightly plastic when wet. Faint mottlings of yellow, reddish brown, and black occur in the lower part.

The material changes very little between 18 inches and about 50 inches. At about 50 inches there is a change to yellowish-brown silt

loam, which is more friable than the layer above but is firm in place and breaks into fine subangular aggregates. This more friable layer may be many feet thick and it overlies a yellowish-brown heavy clay loam or clay that contains some weathered rock. The rock is variegated with grayish yellow and reddish yellow and is apparently weathered residual material from basaltic rock. The depth to the clay loam or clay substratum ranges from 3 to more than 15 feet but is generally more than 9 feet. Fine roots extend to more than 6 feet.

The profile is micaceous throughout, contains no gravel, and is medium to strongly acid. The soil has a high water-holding capacity.

Use and management.—Topography, adequate drainage, and natural fertility make this soil one of the best for general farming in the area. Its deep and friable profile and high water-holding capacity are well suited to grass, forage crops, and fruit. The uncleared areas are now covered with a mixed growth of Douglas-fir, alder, cedar, dogwood, elderberry, mockorange, oak, cascara, Oregon maple, vine maple, Oregon-grape, blackberry, bracken, and other trees and shrubs, and grass. About 70 percent is cultivated. Some of the soil is used for commercial prune and apple orchards, but most of it is used for general farming. About 45 percent of the cultivated area is used for clover, ryegrass, and timothy; 30 percent for oats for grain and hay; 10 percent for corn for silage and grain; and the rest for alfalfa, fruit, and other crops.

Alfalfa produces well when fertilized properly. Applications of lime and superphosphate aid in starting alfalfa. In the past the fertility of the soil was impaired by the custom of growing oats too many years in succession. The fertility of the soil is maintained on dairy farms by growing legumes and buying some grain and concentrated feed, which are later partly returned to the soil in the form of manure. The soil responds to applications of nitrogen and phosphorus.

Felida silt loam, 15 to 30 percent slopes (Fe).—This soil is similar to Felida silt loam, 5 to 15 percent slopes, except for stronger slopes. The soil is usually adjacent to stream gullies and on slopes below Olympic soils.

Almost all uncleared areas are covered with young trees, brush, bracken, and some grass. The soil is largely used for wooded pasture, but about 30 percent is under cultivation and is used chiefly for hay and pasture. Yields are about the same as on Felida silt loam, 5 to 15 percent slopes. Water erosion on cultivated areas is much more prevalent, however, and the steeper areas not in grass should be left in timber or wooded pasture.

Felida silt loam, 30 to 40 percent slopes (Ff).—Except for stronger slope, this soil is similar to Felida silt loam, 15 to 30 percent slopes. The depth to bedrock is usually shallower or more variable, however, and rock outcrops occur in places. This soil is chiefly on eroded benchlike areas and on the lower part of mountainous slopes. Most of this soil is covered with young timber, to which it is best suited. It is too steep to use as cropland.

Felida clay loam, 5 to 15 percent slopes (Fb).—This soil occurs in small areas in the southwestern part of the county. Texture of the surface soil, degree of compaction in the subsoil, and somewhat stronger slopes differentiate it from Felida silt loam, 5 to 15 percent slopes.

This soil has a brown friable clay loam surface layer, about 8 inches thick, that contains many fine shot and is dark brown in the upper part when moist. The weakly granular structure crumbles easily. From 8 to 17 inches is dark yellowish-brown clay loam that has a trace of shot and breaks into fine subangular blocky aggregates that pulverize easily. The material below 17 inches is yellowish-brown heavy silty clay loam that is very firm and breaks down to blocky aggregates and then to subangular blocks. This layer is slightly mottled and in the lower part is less firm. At 60 to 70 inches the soil grades to yellowish-brown friable clay loam or heavy silt loam that is more friable than the above layer. At 96 or 120 inches the profile is underlain by reddish-brown to yellowish-brown clay or heavy clay loam containing some gravel or rock. Fine roots penetrate to more than 72 inches. The profile is medium to strongly acid.

Use and management.—About 65 percent of the soil is cultivated. The hay is often a mixture of clover, ryegrass, and timothy. Oats are grown for hay and grain, and corn for silage. The soil is used like Felida silt loam, 5 to 15 percent slopes, but yields are slightly less.

Cultivated areas are susceptible to erosion. The degree of erosion has been slight so far, but the cultivated steeper slopes need to be carefully protected against washing by winter rains. This precaution is more important than on Felida silt loam, 5 to 15 percent slopes, because this clay loam is less permeable to water.

Felida clay loam, 15 to 30 percent slopes (Fa).—Stronger slopes differentiate this soil from Felida clay loam, 5 to 15 percent slopes. A very small acreage is cultivated. The rest is covered with young timber. The soil is best used for forestry.

Felida loam, 5 to 15 percent slopes (Fc).—This soil is very similar to Felida silt loam, 5 to 15 percent slopes, with which it is associated, but it is coarser textured and has a less compact subsoil that is less plastic when wet. Both soils occupy the same type of positions on generally similar topography, but internal drainage of this soil is slightly more rapid. This soil is associated with other Felida soils and with Hillsboro fine sandy loam, 5 to 15 percent slopes. It does not, however, have the sandy substratum characteristic of the Hillsboro soils.

The 10-inch surface soil is a grayish-brown to brown weakly granular loam to light silt loam. Under this is a brown, friable, slightly finer granular loam. At about 20 inches the material is more firm, is slightly mottled with yellow, brown, and black, and is more variable in texture, or ranges from heavy loam to silty clay loam. Below 48 inches are stratified very fine sands, silts, and clay loams that are slightly compact in place but pulverize readily. This stratified material extends many feet and is underlain by material similar to that found under other Felida soils. In places this soil lies directly over basalt rock. The soil profile is micaceous, free from gravel, and medium to strongly acid.

Use and management.—Approximately 85 percent of the soil is cleared for cultivation (pl. 1, *B*). It has the same use as Felida silt loam, 5 to 15 percent slopes, but it yields slightly better.

Greenwater gravelly sandy loam, 2 to 5 percent slopes (Gc).—Because it is located in a region having cool winters and more than

100 inches of precipitation, this soil shows evidence of podzolization. A thin gray leached layer is frequently present in undisturbed areas. The soil occurs only in the Lewis River Valley, where it is on gently undulating to nearly level river terraces 10 to 100 feet above the river. Some included areas have slopes stronger than 5 percent. The more sloping areas occupy colluvial-like fans at the base of mountainous slopes. Other Greenwater soils and St. Helens soils are closely associated with this soil.

The parent material consists largely of glacial outwash and stream-laid materials that contain variable quantities of pumice. The parent materials other than pumice were derived mainly from basaltic and andesitic rocks. The parent material is very coarse and contains varying quantities of sand, gravel, and boulders. Surface drainage is very slow, and internal drainage is rapid. The native vegetation consists of Douglas-fir, cedar, and some alder, vine maple, and other trees. Salal, Oregon-grape, and ferns make up most of the undergrowth. The greater part of the virgin forest remains.

A 2-inch layer of organic material covers the soil. The upper part of this covering consists of forest litter—twigs, leaves, moss, and fir needles. The lower part consists of dark-brown fairly well decomposed leaf mold that contains a small quantity of sand. This organic layer passes sharply to a gray or somewhat dark-gray gravelly sandy loam that contains considerable pumice. This podzolized gray layer is strongly acid, varies in thickness, and in many places is missing. It is most common in slightly depressional areas and most conspicuous when the soil is dry. Under this gray layer the soil abruptly becomes brown moderately to strongly acid gravelly sandy loam that contains considerable pumice and a trace of shot. Viewed closely, it shows a mixture of rust-brown, gray, and yellowish-brown sand.

The subsoil between 14 and 36 inches is light grayish-brown firm gravelly sandy loam. The sand particles are a mixture of rust brown, yellowish brown, and gray. There are a few waterworn glacial boulders and irregularly stratified layers of sand and gravel. Between 36 and 72 inches the material is porous and incoherent and consists of olive-gray stratified layers of sand, gravel, and rounded boulders. These stratified layers continue without much change to a depth of 10 feet or more. Basalt and andesite rock fragments normally become more prevalent with depth. In some areas, however, considerable rock is scattered over the surface. Fine roots extend to more than 6 feet.

Small areas that have little or no gravel in the surface layer have been included.

Use and management.—Except for a small acreage in hay, practically all of this soil is still forested. Its value for agriculture is very low because it is coarse and porous; it is considered more valuable for timber and recreational purposes. The areas are fairly inaccessible and a great distance from markets.

Greenwater gravelly sand, 2 to 5 percent slopes (Ga).—Except for coarser texture, this soil is much like Greenwater gravelly sandy loam, 2 to 5 percent slopes. It occupies areas near the Lewis River and at the foot of old colluvial slopes in the Lewis River Valley.

Under the 2-inch layer of organic material is brown loose gravelly sand that continues to a depth of about 8 inches. The texture of this

gravelly layer varies greatly because of stratification. On areas of smooth relief a thin gray layer occurs just below the surface layer of organic material. Some pumice particles and many waterworn glacial boulders are in the surface soil, and many boulders are scattered on the surface. Between 8 and 36 inches the subsoil consists of yellowish-brown stratified layers of gravelly sand, sand, gravelly sandy loam, and boulders. This stratified layer is firm to very weakly cemented and stands up well in a cut bank. Below 36 inches are stratified layers of yellowish-brown to gray sand, gravel, and boulders that are loose or faintly coherent but without cementation. The substratum consists of similar material to depths of 10 feet or more. The surface soil and subsoil are moderately to strongly acid.

Use and management.—The gravel, porosity, and droughtiness of this soil do not favor agriculture. Recently some of the timber has been cut, but none of the soil is cultivated because it is considered more valuable for forestry.

Greenwater gravelly sand, 15 to 35 percent slopes (Gb).—Except for stronger relief and generally greater amounts of gravel and stones, this phase is similar to Greenwater gravelly sand, 2 to 5 percent slopes. It occurs on terrace embankments and short steep slopes adjacent to mountainous land. Areas with surface textures varying from sandy loam to gravelly sandy loam are included. The soil is largely in forest and has no value for farming.

Hesson clay loam, 5 to 15 percent slopes (Hb).—This soil occupies rolling areas on old eroded terraces. It is well drained and elevated several hundred feet above the valley floors. It occurs in the southwestern corner of the county with the other Hesson soils and is the eastern extension of the main body of Hesson soils that occurs to the west in Clark County. The parent material is plastic red clay that is frequently interbedded with waterworn rocks, mainly quartzite pebbles and basaltic gravel. Except for the large quantity of small quartzite pebbles throughout the profile, most of the rocks have weathered deeply. This soil has many characteristics of the closely associated Olympic soils and, except for the quartzite gravel, is difficult to distinguish from them. The native vegetation consisted of Douglas-fir, hemlock, and other trees common to well-drained upland soils.

In timbered areas the soil is covered with about 1½ inches of organic material. Below this depth the surface soil is brown to dark-brown clay loam containing many shot to depths of about 4 inches. The shot, $\frac{1}{10}$ to ¼ inch in diameter, are brown on the outside and reddish brown in the inside and are difficult to crush. This layer has a strong medium granular structure. The number of shot decreases with depth.

At about 17 inches the clay loam material grades into firm plastic silty clay loam that breaks into angular blocks at a depth of about 24 inches. This silty clay loam is slightly more yellowish when dry and reddish when moist. It contains a few round quartzite pebbles or cobbles 1 to 4 inches in diameter. These pebbles are coated with reddish-brown stains. There are many fine roots in this layer.

At an average depth of 44 inches the silty clay loam passes sharply to highly weathered red plastic silty clay that contains a few scattered waterworn cobbles. The cobbles are mostly quartzite, as the less

resistant rocks apparently have been decomposed by weathering. This silty clay is splotched or variegated with bright red, brownish red, and yellowish brown. It breaks into firm strong blocks that are hard when dry. Very few roots penetrate this firm material. The depth to this red firm layer varies from about 24 inches in eroded areas to 72 inches in smooth areas and in areas adjacent to Felida clay loams.

The entire profile is strongly acid. A few round pebbles are on the surface in plowed fields.

Small areas near Canyon Creek have basalt rock and gravel scattered in the profile, a gritty clay loam texture, and a more reddish-brown subsoil.

Use and management.—About 70 percent of this soil is cultivated. Nearly 40 percent of the cultivated acreage is planted to a mixture of clover, ryegrass, and timothy. About three-fourths of an acre is needed to provide summer pasture for a cow. Oats, planted on about 30 percent of the cultivated area, are usually cut for hay. They are seldom harvested for grain. Corn is used for both grain and silage. Prunes do well and have produced up to 8 tons of dry prunes an acre. The uncleared areas are covered with Douglas-fir and other trees and are used to some extent for wooded pasture.

This soil is susceptible to erosion. Most cultivated fields have lost 5 to 10 percent of the surface soil by sheet erosion, and the more strongly sloping areas have lost more than 25 percent. Most of this soil should be plowed along the contour and be protected against winter rains by cover crops. Erosion control is recommended for most cultivated areas.

Hesson clay loam, 15 to 30 percent slopes (Ha).—Stronger slopes and, in most places, shallower depth to the red subsoil differentiate this soil from Hesson clay loam, 5 to 15 percent slopes.

About 50 percent of this soil is cultivated, and yields are comparable to those on Hesson clay loam, 5 to 15 percent slopes. Cultivation should be on the contour. Growing of row crops, orchard fruits, and other crops that leave much of the surface without a vegetative cover should be discouraged.

Hesson clay loam, 30 to 40 percent slopes (Hc).—This soil resembles Hesson clay loam, 15 to 30 percent slopes, except that it is more stony and varies more in depth to the substratum. The surface soil, to a depth to about 3 inches, is dark-brown clay loam containing many shot and some gravel. From 3 to 10 inches, it is brown clay loam containing a trace of shot and some gravel. The subsoil between 10 and 36 inches is moderately compact reddish-brown clay loam that contains some gravel and rock. This material is underlain by reddish-brown compact clay loam that contains a large quantity of subangular and rounded rock and gravel and extends to 10 feet or more. The fragments are largely basalt, but some are andesite, quartzite, and other kinds of rock. In places streaks of yellowish-brown and red clay loam are in the upper subsoil. The soil is variable because different materials crop out on the steep slopes.

The soil is covered with Douglas-fir, cedar, alder, maple, other trees, shrubs, and ferns. Its greatest value is for timber, and none of the soil is cultivated.

Hillsboro fine sandy loam, 5 to 15 percent slopes (He).—This soil occurs as small scattered bodies near the Columbia River. It has a brown to grayish-brown surface soil and coarser textured yellowish-brown rapidly permeable lower subsoil and sandy substratum.

The soil has developed on river terraces (pl. 2, *A*) and benchlike areas that are slightly dissected by erosion. The parent materials are of mixed origin—mostly old alluvium but also some windblown material. Drainage is good. The subsoil is rapidly permeable but has fair water-holding capacity. The native vegetation consists of Douglas-fir and hemlock mixed with some cedar, alder, maple, oak and other trees and shrubs.

This soil, like the other Hillsboro soils, is associated with the Skamania and Felida soils. It differs from the Skamania soils in having a less homogeneous profile and a coarser textured lower subsoil and substratum. Skamania soils frequently have angular basalt and andesite stones in the lower part of the profile, but this soil and the other Hillsboro soils are entirely free of stones and gravel. The Hillsboro soils differ from the Felida soils in having coarser textured subsoils and substrata.

A 1-inch layer of organic matter covers the surface in forested areas, but it is largely trampled out where the soil is pastured and soon becomes mixed with the surface soil where cultivated. The 8-inch surface soil is brown to grayish-brown friable fine sandy loam that is dark brown to dark grayish brown when moist. This layer has a grayish cast in cultivated areas, is medium to slightly acid, and contains a trace of shot.

The subsoil extending from 8 to 40 inches is yellowish-brown fine sandy loam to loamy very fine sand of distinctly sandy texture. It stands up well in a cut bank when moist but crumbles easily when dry. This layer is dark yellowish brown when moist and is medium to strongly acid. The texture is coarser and the color becomes more olive with increasing depth.

Between 40 and 60 inches is light yellowish-brown loamy very fine sand or coarse very fine sandy loam that contains a small quantity of mica. The substratum, beginning below 60 inches, is strongly acid, pale-olive, slightly grayish-brown, or yellowish-brown loamy very fine sand. It tends to be stratified in many places and may contain a trace of gravel. Roots penetrate many feet. Usually the entire profile of this soil is relatively free of gravel and stone.

Use and management.—About 70 percent of this soil is cultivated. It is favorable for growing fruit, filberts, and nursery stock but it is used mostly for clover, ryegrass, timothy, corn, and oats. Fairly high yields are obtained by using farm manure liberally.

Owing to its permeability, there is very little water erosion on this soil. In places slight wind erosion and some deposition of windblown material from the Columbia River Valley have taken place.

Hillsboro fine sandy loam, 15 to 30 percent slopes (Hd).—Most of this soil is strongly sloping. It is associated with other Hillsboro soils and differs from them principally in relief, more rapid surface drainage, and greater variability in texture, depth, and color of the various layers. Generally this soil has a sandier, lighter colored, and shallower profile than that of Hillsboro fine sandy loam, 5 to 15 percent

slopes. Only a small acreage occurs in the county, and all of it is in wooded pasture or in brush.

Hillsboro fine sandy loam, 30 to 40 percent slopes (Hf).—Except for stronger slope and shallower depth of profile, this soil is similar to the other Hillsboro soils. Rock outcrops occur occasionally, and the surface texture varies from sandy loam to silt loam. At present this soil is in forest, the use to which it is best suited.

Hood silt loam, 30 to 40 percent slopes (Hk).—This soil occurs in a single area in the northeastern part of the county. It is mainly on the lower part of mountain slopes on an old eroded terrace. It is dissected by relatively shallow valleys that give a steeply rolling appearance. The soil apparently is derived from old silty alluvial deposits modified locally by wind. These deposits were probably laid down over basalt in fairly quiet waters and derived mainly from basaltic and andesitic rocks. Owing to the rough topography, surface drainage is rapid. Internal drainage is medium. The subsoil is moderately permeable and has a good water-holding capacity.

The native vegetation was largely Douglas-fir, but the forest cover is now mostly second-growth timber of Douglas-fir, cedar, Western yellow pine, alder, prairie oak, and an undergrowth of Oregon-grape, soapbush, ferns, and other vines and shrubs.

Virgin areas are covered with an inch of brown organic material—mostly loose forest litter in the upper part and a thin film of partly decayed leaf mold in the lower part. This organic layer is abruptly underlain by grayish-brown silt loam that is almost entirely free from rock or gravel but contains a few soft incipient shot. This silt loam has a moderate organic-matter content and is slightly acid. At a depth of 6 inches the soil is pale-brown friable silt loam that breaks into fine granules. The soil at this depth, like the subsoil below, has a grayish hue in a cut bank.

Between 14 and 34 inches the subsoil is light yellowish-brown firm silt loam or clay loam and has a trace of mica. It is very faintly variegated with rust brown and gray. This material is slightly hard to move with a shovel when dry but breaks readily into blocky aggregates when moist. From 34 to 60 inches is light yellowish-brown firm silt loam that breaks into coarse angular aggregates easily pulverized to finer aggregates. Many tiny holes along old root channels give it a slightly vesicular appearance.

In most places the substratum below 60 inches is micaceous light yellowish-brown silt loam having occasional layers of fine sandy loam. Fine roots penetrate below 60 inches. The entire profile has a distinct grayish cast in a cut bank and is slightly mottled with purple and black in the lower subsoil.

At 4 to 25 feet the soil rests on yellowish-brown to reddish-brown clay loam and weathered lava rock, mostly andesite. The clay loam substratum is shallower where areas border the Underwood soils.

Use and management.—Owing to the steep topography, agriculture is very limited. As the soil occurs in the eastern part of the county where rainfall is limited during the growing period, small grains and hay crops do not yield well. The soil, however, is very productive if irrigated. The small acreage in cultivation is irrigated and produces alfalfa and such truck crops as onions, strawberries, and potatoes. Without irrigation, yields would be less than half. Unless cleared

areas are carefully managed to prevent erosion, this steep soil is more valuable for growing timber.

Hood silt loam, 15 to 30 percent slopes (Hg).—Its relief is the only characteristic differentiating this soil from other Hood soils. This soil occurs on somewhat eroded terracelike areas. None is cultivated.

Hood silt loam, 2 to 15 percent slopes (Hh).—This soil occurs on rolling benchlike positions and except for slope is similar to other Hood silt loams. None was cultivated at the time of this survey. It is a productive soil, however, and probably will be cleared. Similar soils to the south in Hood River County, Oreg., are extensively used for irrigated fruit.

Lava flows, 15 to 30 percent slopes (La).—This miscellaneous land type consists chiefly of lava rock and has very little true soil. Very frequently the center of the area is a cone or fissure covered with only a few scrubby Douglas-fir, lodgepole pine, Oregon-grape, and other trees and shrubs. Near the borders, the lava rock is broken and partly weathered and contains some disintegrated rock and soil as interstitial material between the rocks. The principal vegetation is scrubby growth of Douglas-fir and other trees.

The surface is covered with about 2 inches of green moss, brown loose fir needles, and fine roots. A dark-brown layer of well-decayed fir needles, moss, and roots and some mineral material fill the depressions in the rocky surface to about 4 inches. Below this depth the soil is grayish-brown gritty clay loam that occurs as interstitial material between the rocks, which are angular, cube-shaped, and 4 to 16 inches in cross section. Soil constitutes about 25 percent of the mass at 12 inches. Below 30 inches there is practically no soil. The lava rock is andesite in most areas, but there is some basalt. The relief is pitted and hummocky and there are numerous bare rock outcrops.

Use and management.—Lava flows are of no value for crops or grazing and have only low value for timber production. Where accessible, however, the rock can be used for ballasting and road building. When crushed for road material, it is locally known as cube-rock. Lava flows differ from the extensive areas of true scabland, which occurs farther east. Unlike Lava flows, scabland may contain small areas of soil suitable for grazing.

Made land (Ma).—Areas built up artificially with soil, rock, or dredged material compose this miscellaneous land type. It also includes areas of some size from which the soil has been removed. The largest areas are embankments of highways and railroads over places formerly covered with water.

Martha clay loam, 0 to 3 percent slopes (Mb).—This inextensive soil is imperfectly drained and mottled with gray. It has been influenced by pumice. It occurs in small areas on terraces in the upper end of the Wind River Valley within the Gifford Pinchot National Forest. It occupies low basin areas or depressions in association with the Stabler soils and was derived from similar parent materials. This soil usually occurs in outer valley positions adjacent to steep upland areas. The topography is nearly level to slightly hummocky. Both surface and internal drainage are restricted. The native vegetation

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consists largely of Douglas-fir, cedar, hemlock, and various deciduous trees.

The 6-inch surface soil is light brownish-gray granular clay loam. The irregular-sized granules are easily crushed when dry but are plastic when wet. A few yellowish-brown pumice fragments occur in the surface soil. The material to about 15 inches is light brownish-gray plastic clay loam. The subangular blocky structure of this plastic layer is more durable when dry than the granular structure of the surface soil. There is a slight increase in the content of pumice and the material is more compact, grayer, and more mottled with gray and yellow with depth, but otherwise there is very little change to a depth of about 2 feet. Below 2 feet the material is plastic highly mottled clay loam that breaks into hard subangular blocky aggregates. This clay is pale olive to olive mottled with yellow, gray, and brown. The mottling increases below 40 inches. The quantity of pumice increases with depth, and below 60 inches the soil consists almost wholly of brownish-yellow mottled pumice and some fine interstitial material.

Variations occur where the surface is hummocky. The soil includes better drained areas on the higher swells that have browner surface soil and less plastic subsoil. Variations also occur in the quantity of pumice. Neither the Martha soil in this area nor its variations have so dark-colored a surface soil or so plastic and compact a subsoil as the somewhat similar Glenoma soils in Lewis County.

Use and management.—This soil is largely in brush consisting of willow, alder, maple, dewberry, ferns, and wild grasses. Areas are used for range pasture, and the small acreage cleared is used with moderate success for oat and rye hay crops.

Nesika gravelly loam, 2 to 5 percent slopes (Na).—This inextensive soil occupies alluvial, fanlike positions at the upper ends of the valleys of the Washougal and Wind Rivers, usually at the base of small tributary streams that drain into the main river valleys. The alluvial parent material, which was derived mostly from basic igneous rocks, has its source in Olympic soils that occupy most of the surrounding mountainous uplands and that developed under high rainfall. The soil is somewhat excessively drained. The native vegetation consists largely of Douglas-fir, hemlock, cedar, and a heavy undergrowth of shrubs and brush.

The 10- to 12-inch surface soil is dark grayish-brown fine granular loam. This layer is high in organic matter, has a moderate quantity of shot, and in places shows a scattering of gravel and angular rock fragments. Below this layer is brown, dark-brown, or yellowish-brown moderately compact loam or clay loam. The slightly plastic material readily crumbles into coarse subangular blocks. Gravel and stones increase with depth, and at about 24 inches the material is brown to yellowish-brown gravelly loam or gravelly sandy loam that is very friable and very porous in the more gravelly areas.

The quantity of gravel and stone is variable throughout the profile. In areas along the Washougal River the part of the profile between 12 and about 24 inches is variable in degree of compaction and color. In places this layer is dark grayish-brown plastic clay loam that is very sporadic and occurs for only short distances. Much of the

parent material along the Washougal River is a heterogeneous mixture of deposits from river terraces, alluvial fans, and colluvial areas.

Use and management.—Only a small acreage in the Wind River Valley is available for cultivation, and the areas along the Washougal River are practically inaccessible. These areas are too small to use as farming units in themselves, and the adjacent land is mountainous. The soil is fairly productive and, where cultivated, is used mostly for pasture and hay crops.

Newberg fine sandy loam, 0 to 3 percent slopes (Nb).—This soil occupies bottom lands or low terraces along streams that overflow during high water. The soil has a nearly level relief characterized by gentle slopes or small swells and swales. It was derived from recent alluvial materials that had their source in a variety of rocks but largely in basic igneous rocks. The soil is well drained except during periods of high water. It differs from the Columbia soils in having browner surface soil and in being derived from more homogeneous materials. The few acres that occur in the county are scattered along the Wind River in the Gifford Pinchot National Forest.

The 10- to 12-inch surface soil is brown friable weakly granular fine sandy loam. It has no shot, but a few pieces of gravel may occur in spots. This layer grades into a lighter brown to yellowish-brown very friable sandy loam or loamy sand. Variegated gray, yellow, and brown permeable sand occurs at 20 inches. Occasionally this sand may be slightly firm in place but it crumbles easily into a single-grained structure when removed. In a few places gravel occurs below 3 feet.

Use and management.—Only a small acreage is cultivated and the rest is in wooded pasture and brush. The soil is productive, and where it is in large enough areas, it is used for hay crops, principally oats and legumes.

Olympic clay loam, 2 to 15 percent slopes (Ob).—This soil, which resembles the Olympic stony clay loam soils in many respects, has developed from lava rocks, largely basalt. Although associated with other Olympic soils in the southwestern part of the area, it generally occurs at lower elevations closer to the Columbia River. Surface drainage is slow to medium and drainage through the soil is medium. The original cover, largely Douglas-fir, has been replaced by a second growth of alder and other hardwoods. This is the only soil of the Olympic series suitable for cultivation.

The profile is similar to that of Olympic stony clay loam, 2 to 15 percent slopes, except that it has deeper darker surface soil and has less stone in the top 30 inches. In virgin areas it is covered with about 1½ inches of organic material. At the top is about ½ inch of brown loose fir needles, fern fronds, twigs, and other forest litter. The litter at the top grades into dark-brown fairly well decayed leaf mold that contains many white molds. This leaf mold is bound with fine roots from the underbrush. The lower part contains considerable mineral soil.

The organic layer passes into dark-brown to dark grayish-brown clay loam that contains many brown-colored shot. The shot are round pellets $\frac{1}{10}$- to ¼-inch in diameter. Some angular gravel and a few rocks are scattered over the surface. The structure is subangular blocky, and the organic content is fairly high. When this layer is moist it is very dark brown to black.

At an average depth of 5 inches the soil is clay loam, similar to the layer above in color, that contains a small quantity of shot and is acid in reaction. It is relatively plastic when wet and when dry breaks into subangular blocky pea-sized or small nut-sized moderately stable aggregates. After a few years of cultivation the organic layer at the surface is mixed with this mineral layer and the result is a layer generally dark brown or brown. There are many angular fragments of basalt and scattered large rocks.

At an average depth of 17 inches brown heavy clay loam or silty clay occurs; it is plastic when wet, slightly compact when dry, and breaks into a subangular blocky structure. There are many fine roots. The organic content is very low. A cut bank shows this layer to be more red than other parts of the profile. In places it is distinctly reddish brown to red.

Heavy clay loam substratum begins at 30 inches; it is lighter brown than the layer above when dry and dark reddish brown when moist. Many angular stones and pieces of gravel, in addition to the greenish-brown partly decomposed basalt, occur in this layer. The color ranges between yellowish brown and reddish brown. The number of rock fragments increases with depth and the material becomes finer but less firm.

At 60 inches the substratum grades into yellowish-brown clay, finely variegated with reddish brown and splotched with grayish brown and greenish brown from decayed basalt or andesite rock. This layer continues to about 8 feet and is underlain by partly weathered rock. The depth to the rock varies from 2 to 10 feet or more within short distances. Areas bordering Olympic stony clay loams are more shallow to bedrock. The demarcation between this soil and the Olympic stony clay loams is not sharp, and many areas slowly grade between the two.

The larger part of Olympic clay loam, 2 to 15 percent slopes, has developed from basalt, and the rest from andesite. The areas that have developed from andesite are somewhat coarser textured and have a more permeable subsoil. The largest area developed from andesite is north of Beacon Rock and Skamania.

Areas near Cape Horn School have a deeper more permeable subsoil than typical. In this locality the soil was derived from residual material covered with more or less sedimentary parent material. Areas north of Bear Prairie have a darker surface soil and a greater depth to rock than the average for Olympic soils. In general the subsoil is more reddish in the western part of the area and more gray to the east.

Use and management.—Most of the original timber—Douglas-fir—has been cut or burned off and the soil is now covered with second-growth alder and other hardwoods and some stocking of Douglas-fir. The soil is not considered very productive, and less than 2 percent is cultivated (pl. 2, *B*). Many formerly cultivated areas have been abandoned.

This soil is easily susceptible to erosion. The cultivated fields on the stronger slopes show more erosion than fields on any other soil in the area. Most areas are kept in hay and pasture crops, which help to retard erosion and are the crops to which the soil is best suited.

Clover grown with ryegrass and timothy is the most important crop. Oats for hay or grain are grown on about 25 percent of the cultivated

acreage. Apples, pears, prunes, cherries, and filberts are grown to some extent for home use and do fairly well on the areas that have the deeper profiles.

Olympic clay loam, 15 to 30 percent slopes (Oa).—This soil is similar to Olympic clay loam, 2 to 15 percent slopes, except in having somewhat stronger relief. Areas are dissected by a dendritic drainage system. Practically none of this soil is cultivated. It is better for growing timber than for farming. A large part is covered by second-growth timber and ferns.

Olympic clay loam, 30 to 70 percent slopes (Oc).—In most characteristics other than slope, this soil resembles Olympic clay loam, 2 to 15 percent slopes. It is ordinarily more stony and more shallow. It covers large tracts in the southwestern part of the county. The original forest was the same as that on the other Olympic soils. Most of the old timber has been cut or burned, but a fair second growth of Douglas-fir covers most areas.

Olympic stony clay loam, 30 to 60 percent slopes (Of).—This soil occurs in the southwestern part of the area in association with St. Martin, Stevenson, and other Olympic soils. It has developed from lava rocks, largely basalt, that underlie the soil at extremely variable depths. The relief is distinctly mountainous. The areas are dissected by V-shaped gullies. Differences in elevation of as much as 1,000 feet in a mile are common. The drainage system is complete. Surface drainage is very rapid and internal drainage is medium. The original cover consisted largely of Douglas-fir and scattered Western redcedar. Hemlock, balsam fir, and assorted species grew at the higher altitudes.

At the surface is about 1½ inches of organic material consisting of loose leaves, twigs, and fir needles. Fairly well decomposed leaf mold containing some mineral soil makes up the lower part of this layer. The depth of the organic matter varies considerably and may be as much as 5 inches in hollows between the rocks.

The organic layer is underlain by brown or dark-brown clay loam that contains many shot, pieces of gravel, and angular stones. Many stones are scattered over the surface. The structure is medium granular and moderately stable. The layer is bound with fine and coarse roots. It contains a fairly high quantity of organic material. The reaction is strongly acid.

From 6 to 17 inches is yellowish-red clay loam that contains many rocks and angular gravel. The color is dark reddish brown when moist. Fine roots are plentiful, and traces of shot go all the way to the lower part. The soil is sticky when wet but has a gritty feel caused by fragments of disintegrated rock. It breaks into pea-sized or small subangular blocky fragments.

The subsoil between 17 and 30 inches is reddish-yellow to brownish-yellow heavy clay loam or clay that occurs as interstitial material between the rocks. This subsoil is sticky and moderately plastic when wet, but it is gritty because it contains some disintegrated rock. About 30 percent of the layer consists of rock, the quantity of which increases with depth. Between 30 and 60 inches, reddish-yellow to yellowish-red stony heavy clay loam or clay occurs. This material consists of more than 50 percent rock and contains many fine variegations of olive-brown and grayish-brown material from disintegrated

rock. The color changes within short distances and in places is dark red. The soil is underlain by lava rock at an average depth of 6 feet, although the depth may vary from a few inches to 10 feet or more within short distances. Rock outcrops are common.

As mapped, the soil includes some areas relatively free from rock that were not separately delineated on the map because the rough landscape made them difficult to survey. Roots penetrate to 6 feet or more, depending on the depth to consolidated rock.

Small areas north of Skamania and Beacon Rock that developed from andesite are also included. These areas approach a loam texture and are somewhat coarse.

Use and management.—None of this soil is under cultivation. Because it is mountainous and stony it is distinctly a nonagricultural soil suited only to timber. Much of the original timber has been cut or destroyed by fire. Near the Washougal River the soil is covered with a dense growth of ferns and some brush and has little second-growth forest, but other denuded areas, although largely covered with young alder and willow brush, have a good restocking of young Douglas-fir. This soil is especially suited to Douglas-fir.

Bracken is a pest on denuded areas; it ruins the grazing value of the soil but it has helped prevent erosion. Practically no recent erosion is visible on the soil, although a slight amount probably has taken place in denuded areas. All areas are still covered with leaf mold, which retards runoff and also has been effective in preventing erosion.

Olympic stony clay loam, 15 to 30 percent slopes (Od).—This soil is similar to Olympic stony clay loam, 30 to 60 percent slopes, except it is rolling to hilly, is slightly less rocky, and has fewer rock outcrops even though it is dissected by V-shaped gullies that are mostly 25 to 200 feet deep.

This soil is not extensive, and none of it is cultivated. It is suited only to timber.

Olympic stony clay loam, 2 to 15 percent slopes (Oe).—This inextensive soil occurs largely on slightly eroded high benchlike areas. The surface drainage is slow to medium. The profile is similar to that of Olympic stony clay loam, 30 to 60 percent slopes. In places the surface soil is slightly darker, and the depth to rock is a little greater. None of this soil is cultivated. It is best used for forestry.

Olympic stony loam, 30 to 70 percent slopes (Ok).—This inextensive soil is very similar to Olympic stony clay loam, 30 to 60 percent slopes, except in surface soil texture. Below a 1½ inch layer of partly decomposed organic matter is a dark grayish-brown to dark reddish-brown gritty heavy loam that contains a large number of shot, angular stones, and fragments of stone. The structure is weakly granular.

The subsoil is reddish-brown heavy loam containing less shot than the surface soil and considerably more angular stones and gravel. In most areas this layer is dark reddish brown when moist. It is friable and breaks into subangular blocky structural aggregates. From 17 to 30 inches is slightly lighter reddish-brown clay loam.

The number of stones increases with depth so that below 30 inches the substratum is very stony clay loam. The material at this depth is reddish brown to yellowish red when dry and dark red when moist.

The depth to the partly decomposed or consolidated rock is extremely variable within short distances. Rock outcrops are common. The rock consists largely of andesite and some basalt.

A small area underlain by granite south of the Skamania mines is included with the soil as mapped.

Use and management.—Douglas-fir and a few cedar, hemlock, and other trees formerly covered this soil. Most of the virgin timber, which was cut or destroyed by fire, has been replaced. The present vegetation is young alder, willow, bracken, and a scattered restocking of Douglas-fir. None of this soil is cultivated. It is considered nonagricultural and is best suited to the production of Douglas-fir.

Olympic stony loam, 15 to 30 percent slopes (Og).—Although it has milder slopes, this soil is similar to the associated Olympic stony loam, 30 to 70 percent slopes. The depth to the stony substratum, however, is not so variable. None of the soil is cultivated, and it is best used for forestry.

Olympic stony loam, 2 to 15 percent slopes (Oh).—Relief is the chief differentiation between this soil and the other Olympic stony loam soils. Its profile is otherwise similar. None of it is cultivated, and stoniness makes it best suited to timber.

Riffe fine sandy loam, 0 to 3 percent slopes (Rb).—Areas of this soil occupy nearly level to gently sloping high terraces several hundred feet above the present flood plain of the Wind River. The soil consists of a brown shotty permeable surface soil and coarser textured lower subsoil. The substratum, or parent material, is loose loamy sand to sandy alluvium derived from mixed materials, largely basic igneous.

The soil has a shallower and more shotty surface soil and a coarser sandy lower subsoil and substratum than the Hillsboro soils. Both are associated with Wind River and Stabler soils. It lacks, however, the pumice of the Stabler soils and the gravelly substratum of the Wind River soils. It has a more sandy subsoil than the Stabler soil.

Timbered areas are covered with about 1½ inches of organic material. Below this to a depth of about 3 inches, the surface soil is brown to dark-brown shotty fine sandy loam. Below this and continuing to 9 inches is brown shotty fine sandy loam, which contains much fine silt and very fine sand but has a gritty feel because of the shot. The surface organic layer is mixed with the surface soil in cultivated areas.

Between 9 and 17 inches is yellowish-brown fine sandy loam that contains considerable shot and is strongly acid. It changes abruptly to lighter yellowish-brown very fine sandy loam that has a friable to firm consistence and is practically shot-free.

Below 30 inches the soil is light yellowish-brown fine sandy loam to loamy sand. This material becomes coarser with depth and is underlain by loose yellowish-brown loamy fine sand, sand, and some gravel at 4 to 8 feet.

Use and management.—Most of the acreage is covered with young Douglas-fir and other trees. About 15 percent is under cultivation. Some of the cultivated areas are in young orchards; the rest is used for clover, timothy, oats, general farm crops, and truck and berry crops (pl. 3, *A*). Most crops would benefit by irrigation, as the soil becomes very dry during summer.

Riffe fine sandy loam, 3 to 15 percent slopes (Ra).—This soil occupies single slopes on sites between the terrace breaks and the undulating areas. Its profile is similar to that of Riffe fine sandy loam, 0 to 3 percent slopes, but the lower subsoil and substratum are more loose and sandy. Some gravel may be encountered above a depth of 4 feet. All of this soil is in second-growth timber and wooded pasture.

Riverwash, 0 to 5 percent slopes (Rc).—This land type consists of brownish-gray sand and gravel near the channels of the larger streams. The soil material—sand, gravel, and waterworn boulders—is recent alluvium on which no soil development has taken place. On islands in the Columbia River most of it is gray barren sand. All areas are flooded during high water.

Riverwash has no agricultural value but furnishes excellent commercial sand and gravel. Areas near the streams are barren. At the border away from the streams, this land type is partly covered with a growth of scrubby willow and cottonwood.

Rock outcrop, 50 to 70 percent slopes (Rd).—This miscellaneous land type consists of barren rock. It has little or no soil cover and supports no vegetation except occasional scrubby Douglas-firs and some moss and lichens. The upper slopes in many places are nearly perpendicular cliffs, and the lower slopes are slide-rock or talus material. Some barren mountain peaks and extinct volcanos are included. Most of the relief is precipitous. The rock is chiefly basalt and andesite. From a distance these areas are a dark brown, although in places where the outcrop is of interstratified lava and sedimentary rock, the color is reddish brown. Where accessible, the rock is used for ballast, riprap, and road material. Its only other value is for scenic and recreational purposes.

Unlike Rough mountainous land, Rock outcrop has little or no soil cover. Being barren and precipitous, it also differs from Lava flows, which are not very steep and are covered with scrubby trees.

Rough broken land, 30 to 70 percent slopes (Re).—This miscellaneous land type was formerly covered with timber, mainly Douglas-fir. It occurs in the extreme southwestern corner of the county on terrace breaks along the Columbia River. The parent material, known by geologists as Trout Lake formation, consists of indurated conglomerate of waterworn gravel and cobbles and some fine interstitial material. The deposit is more than 100 feet thick. Surface drainage is very rapid, and internal drainage is slow because of the partly cemented substratum.

On timbered areas Rough broken land is covered with a thin layer of loose leaves and partly decayed forest litter. The surface soil is dark grayish-brown gravelly heavy clay loam to about 6 inches. The texture ranges from gravelly clay loam on the upper part of the slopes to coarse gravelly sandy loam on the lower part. The texture is variable because the soil developed on outcrops of stratified material. The reaction is slightly to medium acid. Some rounded rock is found on the surface.

Between 6 and about 18 inches is brown weakly to firmly cemented gravelly loam that contains much partly disintegrated rock and gravel and is hard to break up with a shovel. The soil between the

gravel is plastic when wet. Rust-brown stains and fine mottling give the soil a faint reddish hue.

The subsoil is underlain by an old alluvial deposit of yellowish-brown indurated or firmly cemented gravel and small waterworn cobbles. The cobbles are 2 to 6 inches in diameter and consist of mixed lava and metamorphic and other rocks. The interstitial material is rust brown to yellowish brown. Most of the gravel is coated with fine material. This layer is very hard to penetrate with a crowbar and stands up like solid rock in a cut bank. Roots do not penetrate it. The deposit is more than 100 feet thick.

Use and management.—The original forest of Douglas-fir was cut years ago. The present cover consists of a dense young growth of alder, oak, maple, Douglas-fir, and other trees and shrubs. Because of the rocky, gravelly, and very steep slopes, this land type has no agricultural value. Its best use is for timber.

Rough mountainous land, 50 to 60 percent slopes (Rf).—This miscellaneous land type consists of rough mountainous areas having a stony thin covering of soil material over rock. It is mapped on many nearly perpendicular cliffs and small flat-topped mountain areas and is cut by V-shaped canyons and gullies characteristic of the Cascade Mountains. Most of these canyons are 200 to 800 feet deep but in places the difference in elevation between the upper and lower slopes may be as much as 3,000 feet.

The underlying rock is mostly basalt or andesite. The area on the western fork of the Washougal River near the Skamania mine in the western part of the county is underlain by granite. Areas near the Lewis River in the northern part of the county are partly covered with a mantle of pumice and volcanic ash, but the underlying rock is mostly basalt.

Rough mountainous land resembles the steep areas of Olympic stony loam and stony clay loam except that it is stonier and shallower to bedrock. Rock outcrops are numerous. Most areas between the rock outcrops are covered with about 1½ inches of organic material, the upper part of which consists of brown loose fir needles and leaves and the lower part of dark-brown fairly well decomposed leaf mold containing some mineral soil. The surface soil below this layer, to a depth of 2 or 3 inches, is dark grayish-brown gritty clay loam that grades into dark-brown gritty clay loam. All of the surface layer contains some shot, and the lower part has a high proportion of angular rock and gravel. Numerous stones and boulders are scattered over the surface.

Between 10 and 20 inches is mostly reddish-brown to yellowish-brown gritty clay loam containing much angular rock and gravel. The quantity of rock increases with depth, and from 20 to 30 inches the interstitial material between angular rocks and rock fragments consists of yellowish-brown to reddish-brown gritty clay loam. Weathered rock begins at 2 to 5 feet. Rock outcrops are common over small areas on the upper parts of mountain slopes. The depth to solid rock may be more than 30 feet on the lower parts of mountain slopes where talus or colluvial material has accumulated.

Use and management.—Rough mountainous land was formerly covered with a fair growth of Douglas-fir on the lower elevations and hemlock, white fir, balsam fir, larch, spruce, cedar, and associated

trees on the higher elevations. Only a small part of the original timber remains. Large areas were denuded by the fire of 1902 and later fires. Restocking has been slow on the upper branches of the Washougal River and on Siouxon Creek, and these areas are mostly covered with bracken, some brush, and a few young trees. The native vegetation and second-growth timber is of poorer quality than on the associated Olympic soils. Most of the native timber still standing is on inaccessible areas. None of Rough mountainous land is under cultivation as it has no agricultural value. It is best used for timber and recreational purposes.

St. Helens pumicy sandy loam, 30 to 70 percent slopes (Sb).—This soil has developed under an average annual rainfall of more than 120 inches from an almost pure pumic deposit. It occupies rough mountainous terrain. The areas are dissected by V-shaped canyons. Rock outcrops occur in places on the steeper slopes.

The soil is underlain by Olympic soil material or basalt or andesite rock, but it was derived from successive deposits of pumice comparatively recently erupted from volcanoes. The deposits may vary from a few inches to more than 25 feet in depth where the soil joins the Olympic soils to south and the pumic deposits are shallower.

A stand of Douglas-fir covers most areas. Some hemlock, cedar, white pine, alder, and other species are included. There is a thick, short undergrowth of salal, and moss is prevalent. Much of the timber is young and less than 2 feet in diameter. Hemlock, alpine fir, and associated species predominate at altitudes above 2,500 feet.

The soil occurs only in the Lewis River area and occupies the mountain slopes bordering the river south of Mount St. Helens.

The surface is covered with a layer of organic material, which usually is 3 inches deep but may range from 2 to 5 inches or more. The upper inch generally consists of undecomposed forest litter, fir needles, salal leaves, bark, and twigs; the middle, partly disintegrated leaf mold and many white molds; and the lower inch, dark-brown fairly well decomposed leaf mold containing some sand. This layer, bound together by roots from shrubs and trees, passes sharply into a gray pumicy loamy sand. This loamy sand is about 1½ inches thick and contains many light-gray pumice fragments up to ⅓ inch in diameter. The thickness varies considerably. The lower part is slightly more yellowish gray. This color is conspicuous when the soil is dry and less distinct when moist. The layer is highly leached and strongly acid.

Underlying the leached layer is pale-yellow to pale-brown sandy loam that contains a high proportion of pumice fragments, many up to ¼ inch in diameter. The pumice gives the soil in a cut bank a grayish cast when dry and a yellowish-brown hue when moist. The organic content is low, and the reaction is strongly acid.

Between 18 and 30 inches is pale yellowish-brown sandy loam containing some gray pumice fragments and, in places, thin slabs of dark-brown weakly cemented soil. The dark brown is variegated with reddish, yellowish, and grayish brown. Between 30 and 50 inches is pale-yellow sandy loam that is mottled with rust brown and grayish brown and contains much pumice sand. It breaks into irregular blocks more than 4 inches in cross section.

Pale-yellow pumicy sandy loam, firm and not so compact as the layer above, goes down to depths of about 6 feet in places. This layer is variegated with rust brown and grayish brown. Next in the profile is reddish-brown clay loam that rests on basalt or andesite rock.

The mantle of pumice and volcanic ash from which the soil has developed varies greatly in depth. It is deep near Mount St. Helens and becomes more shallow to the south. It may be more than 25 feet thick in basinlike areas and at the foot of colluvial slopes. Many rock outcrops are on steep areas. In most places fine plant roots go down to more than 6 feet. The soil material has a somewhat stratified appearance caused by different layers of pumicelike material. At a depth of 6 feet in some places, there is a loamy fine sand that is always moist and has a characteristic greasy feel.

Use and management.—The rough topography and porous character of this soil limits its use to forestry. Much of the timber has been logged recently. The timber on the tract near Mount Mitchell has been destroyed by forest fires, and the area is now covered by bracken and some brush. The timber is difficult to log because of the mountainous terrain. It is estimated that some areas covered by large trees will produce more than 60,000 board feet an acre.

St. Helens pumicy sandy loam, 15 to 30 percent slopes (S).—Most of this soil is in sloping basinlike areas or on the crests of ridges. The most important difference between the profile of this soil and that in areas of steeper relief is the greater depth to rock. In one area the depth appears to be more than 25 feet in most places. Areas on the crests of ridges have shallower soil. This soil also differs from the steep areas in having a heavier stand of timber and in being more accessible for logging. Most areas have been logged off, however, and are now producing a second growth of timber.

St. Helens pumicy sandy loam, 2 to 15 percent slopes (Sa).—This soil occurs in small scattered bodies on benchlike areas. In general the soil is similar to St. Helens pumicy sandy loam, 30 to 70 percent slopes, except that its depth to rock is greater and the stand of timber is heavier. Most of it is covered with virgin timber, and none is under cultivation.

St. Martin clay loam, 30 to 40 percent slopes (Se).—This soil occupies steep and mountainous terrain in the south-central part of the area where the annual rainfall is more than 70 inches. The soil is closely associated with the Olympic soils, which also have developed from weathered basic igneous rocks, largely basalt. More andesite is in the parent material of this and the other St. Martin soils than in the Olympic soils. St. Martin soils differ from the Olympic in having a much darker surface soil and heavier more gray and plastic subsoil. Apparently these differences result from the St. Martin soils having a greater proportion of andesitic rock rather than basalt for parent material.

Surface drainage is very rapid, and internal drainage is slow. All this soil was formerly covered with Douglas-fir and other species common to the uplands.

About 1½ inches of organic material covers the surface of this soil. The upper part of this layer consists of brown loose forest litter; the

lower, fairly well decomposed organic material. The depth ranges from ½ to 3 inches.

The 3- to 4-inch upper surface soil is granular clay loam that contains some angular rock and a small quantity of shot. It is very dark gray when dry and black when moist. It is rootbound, has a fairly high organic-matter content, and is strongly acid. At an average depth of 5 inches is dark-gray to grayish-brown heavy clay loam containing some angular rock and a trace of shot. It has many fine roots, although fewer than in the layer above, and contains considerable organic material. When moist it is very dark gray to black. This layer ranges from clay loam to silty clay in texture and is slightly gritty because it contains disintegrated rock fragments. It is moderately plastic when wet but crumbles fairly easily when dry. It breaks down to durable pea-sized, subangular blocky aggregates.

Between 16 and 30 inches is the grayish-brown to dark grayish-brown silty clay loam or silty clay. It is very plastic and sticky and contains considerable angular rock. Some variegations of yellow and gray occur. Between 30 and 70 inches is grayish-yellowish-brown material variegated with rust-brown and yellowish-brown silty clay and streaked with reddish brown and green.

The substratum contains a large quantity of partly decomposed angular fragments. These consist of basalt, andesite, much greenish, copper-stained rock, and other associated rocks. The quantity of rock increases with depth. Most areas appear to be underlain by partly weathered bedrock at about 10 feet. Fine roots extend to 48 inches or more. The reaction of the substratum is medium to strongly acid. It is sticky and very plastic, but moisture penetrates it readily and it has a good water-holding capacity.

Use and management.—Douglas-fir and small numbers of other trees formerly covered this soil. Most of the larger trees have been cut, but a second growth of Douglas-fir still covers many areas. Owing to the steep and mountainous relief, none of the soil is cultivated. Most areas are still partly forested and covered with leaf mold; consequently, there is little or no perceptible erosion. The soil would erode easily, however, if denuded of timber.

St. Martin clay loam, 15 to 30 percent slopes (Sc).—Except for its gentler slopes, this soil is similar to St. Martin clay loam, 30 to 40 percent slopes. None of it is cultivated, and it is more valuable for timber.

St. Martin clay loam, 2 to 15 percent slopes (Sd).—Although similar to St. Martin clay loam, 30 to 40 percent slopes, in many respects, this soil is usually heavier textured, more plastic, and lighter gray in the upper subsoil. It occurs on high, slightly eroded bench-like areas, practically none of which are cultivated. The soil becomes very dry and hard during the rainless summer months and is not desirable for farming.

St. Martin stony clay loam, 30 to 50 percent slopes (Sh).—This soil has relief and topographic position similar to those of steep areas of St. Martin clay loam, with which it is associated. It generally occupies higher more mountainous areas where there are many steep V-shaped gullies more than 200 feet deep and is more stony than the clay loam. The surface soil of this stony clay loam is

generally not so deep nor so dark as that of St. Martin clay loam, 30 to 40 percent slopes.

The 1½-inch covering of organic material passes sharply to gray or dark-gray clay loam containing considerable angular rock and gravel and a trace of shot. Many fine roots give this material a strong granular structure. The organic content is fairly high. Numerous stones are scattered over the surface. The reaction is strongly to medium acid. The soil is plastic when wet but has a gritty feel caused by the content of partly disintegrated rock. The color is very dark gray to black when moist.

At an average depth of 5 inches is dark-gray to grayish-brown heavy clay loam containing much angular rock and gravel and trace of shot. This layer contains considerable organic material and is dark grayish brown when moist. It breaks into pea-sized subangular blocky aggregates.

The subsoil between 15 and 30 inches is light brownish-gray and gray clay loam or silty clay mottled with yellowish brown and rust brown and containing many fine roots. The organic content is low, and the reaction is medium to strongly acid. The content of angular rock and rock fragments is high in this layer and increases with depth.

From 30 to 70 inches is grayish, yellowish-brown, or light brownish-gray clay highly mottled with yellow, brown, and gray. Fine roots go down to 48 inches or more. Moisture penetrates the subsoil slowly. Internal drainage is restricted. Angular rock fragments occupy nearly half the layer.

At an average depth of 8 feet lies partly weathered bedrock consisting of andesite, basalt, and associated rocks. In some places streaks of green copper-stained rock occur. The depth to the rock varies greatly, and there are many outcrops.

Use and management.—Most of the heavy growth of Douglas-fir that formerly covered the soil has been cut, and the vegetation is largely brush, ferns, young Douglas-fir, and other young trees. There is very little grass. Horses and cattle cannot graze these cutover areas because of fallen logs, thick brush, and steep relief. This soil is best suited to timber.

St. Martin stony clay loam, 15 to 30 percent slopes (Sf).—The soil profile and other characteristics are the same as for St. Martin stony clay loam, 30 to 50 percent slopes. A small area has been partly cleared for pasture, but none is cultivated. The soil is too stony and steep for crops.

St. Martin stony clay loam, 2 to 15 percent slopes (Sg).—Smoother relief and fewer rock outcrops and surface stones are the principal differences between this soil and the steep areas. This soil is too stony for cultivation and is best used for timber and wooded pasture.

Semiahmoo muck, 0 to 2 percent slopes (Si).—This organic soil is derived from well-decomposed sedge accumulations having some intermixture of woody and mineral materials. The surface layer consists of dark-brown to black well-decomposed muck that extends to a depth of about 14 inches and contains some mineral soil and a trace of charred woody fragments. Many roots from grass, sedges, and brush are also present. The reaction is medium acid. This surface layer is underlain by dark-brown sedge muck having some

interbedded woody fragments, fine fibrous material, decayed wood, and mineral soil. Below 24 to 28 inches is dark-brown to brown sedge peat containing much fine fibrous material, which to a depth of more than 60 inches is apparently derived mainly from sedges.

Only two small bodies of this organic soil were found in the county. They are associated with steep soils of the uplands and are covered with marshgrass, sedges, spirea, and other brush. The areas have been partly drained to increase their value for pasture, but they are too small and isolated to be of any importance for farming. Where they occur in larger areas and in association with other agricultural soils, they would be excellent for many crops.

Semiahmoo muck, shallow, 0 to 2 percent slopes (Sj).—This soil consists of areas of Semiahmoo muck underlain by mineral soil at depths of 24 inches or less. It consists of dark-brown to black sedge muck ranging from 6 to 24 inches deep but usually 12 inches deep. The muck is underlain by mottled grayish-brown mineral soil that is mostly clay loam but includes some gravelly material.

The shallow muck is found in numerous deep small depressions in association with soils of the uplands. The total acreage is very small. The vegetation is similar to that on the normal, or deeper, Semiahmoo muck. Most areas would be difficult to drain and would be of limited value, if drained, because of their small extent. The muck is covered with water during winter. It is used only for timber.

Skamania silt loam, 2 to 15 percent slopes (Sl).—This inextensive soil occupies scattered gently rolling to rolling river terraces and benchlike areas above the Columbia River, where it is associated with dissected areas occupied by Skamania silt loam, 30 to 40 percent slopes. The soil has developed from mixed alluvial, colluvial, and loess materials derived from a wide variety of rocks, but chiefly basalt and andesite. The angular rock fragments, mainly basalt and andesite, interbedded in the lower part of the profile are of colluvial origin. Except for the stones the soil profile is uniform in color and texture. The surface soil is grayish brown, and the subsoil is yellowish-brown very fine sandy loam to light silt loam that extends to depths of many feet in places. The subsoil has a high percentage of very fine uniform-sized sand grains.

Internal drainage is medium. Drainage channels of the smaller streams crossing areas of this soil are indefinite. Frequently the streams disappear in sinkholes and appear again lower down the slopes. The native vegetation consists mostly of Douglas-fir, but there is some hemlock, cedar, alder, and maple and an understory of salal, Oregon-grape, and other shrubs. Some areas approximately 40 acres in size are isolated on benchlike positions surrounded by Olympic soils.

About 1½ inches of dark-brown organic material covers the surface soil in virgin areas. The surface soil is grayish-brown granular silt loam or loam that contains many shot to a depth of 5 or 6 inches. It has a moderate supply of organic material, and the reaction is medium to strongly acid. The surface organic layer has been mixed with the surface soil in cultivated areas. The mixture of the two layers produces a dark-brown, faintly grayish, plow layer.

Under the surface layer is brown weakly granular silt loam to silty very fine sandy loam that contains many shot and has a gritty

feel caused by its shot content. The shot are rust brown with red centers and range from 1/10 to 1/25 inch in diameter. They can be cut easily with a knife. The material between 15 and 36 inches is yellowish-brown very fine sandy loam or light silt loam that breaks into small irregular fragments that are easily pulverized into a single-grain structure. This layer is medium acid and may contain some angular stones.

At an average depth of 36 inches the profile grades to yellowish-brown light silt loam, which occurs in spaces between the rocks. The texture ranges from silt loam to very fine sandy loam. The angular and irregularly shaped rocks are mostly basalt or andesite. They have the appearance of being slide-rock or talus material embedded in silt and are easily removed from the soil mass. The quantity of rock is extremely variable within short distances. In places there is some quartzite. The whole mass is moderately permeable to moisture.

Fine roots penetrate to 72 inches or more between the rocks. Some faint yellowish-brown and grayish-brown mottling occurs below 40 inches. The substratum continues with little change to 10 feet or more. There are a few outcrops of basalt rock or extremely stony spots.

Use and management.—The heavy virgin stand of Douglas-fir has been cut, and more than 50 percent of the soil is cultivated to the common crops of the region. Clover, timothy, and oats are grown. Apples, prunes, and bramble fruits do well but are grown only for home use.

Skamania silt loam, 15 to 30 percent slopes (Sk).—This inextensive soil is closely associated with other Skamania soils. It differs from Skamania silt loam, 2 to 15 percent slopes, mainly in having more stones throughout the profile. Rock outcrops and pieces of rock scattered on the surface are also more common. Practically none of this soil is cultivated. Owing to its steeper slopes, this soil would be more susceptible to erosion under cultivation than Skamania silt loam, 2 to 15 percent slopes.

Skamania silt loam, 30 to 40 percent slopes (Sm).—This soil is similar to Skamania silt loam, 15 to 30 percent slopes, but is more shallow and stony. None of it is cultivated. It has no value for agriculture but is well suited to timber.

Skamania very fine sandy loam, 2 to 15 percent slopes (So).—This soil does not occur on such high terraces as the Skamania silt loams; it generally is confined to small isolated lower terraces near the Columbia River.

The alluvial material of these lower terraces appears to have been more modified by windblown material than that on the higher terraces. Judging by road cuts, this soil has formed on an irregular rocky substratum covered with windblown colluvial material. The depth to the rocky substratum or to solid bedrock ranges from 3 to 10 feet or more in short distances. The water-holding capacity is moderate. Areas of this soil occur with the other Skamania very fine sandy loams, but east of Stevenson this soil is largely associated with Hillsboro soils.

This soil has a coarser textured and lighter colored profile than Skamania silt loam, 2 to 15 percent slopes. The surface soil is

brown to yellowish-brown very fine sandy loam to very fine sand to a depth of about 7 inches. The color is slightly dark brown when moist, and the finer textured areas are even darker. The layer contains a trace of shot. There are many fine roots, but the organic content is relatively low. The soil is medium to strongly acid.

The surface soil grades into light yellowish-brown very fine sandy loam at 7 inches and into light yellowish-brown loamy very fine sand at about 17 inches. It contains a small quantity of mica. In a road bank it is quite coherent when moist but readily breaks down to a loose incoherent structure when removed and dry. Faint horizontal to wavelike laminations give it a horizontal breakage in many places. Very little change occurs for many feet, but at about 36 inches the material is a slightly paler light yellowish-brown loamy very fine sand that contains a small quantity of rock and some mica. The texture is uniform and feels slightly silty when moist. The reaction is strongly acid. Fine roots extend to 6 feet or more.

Below 5 feet the substratum consists of angular rock fragments and silty interstitial material or solid basalt rock. The depth to rock ranges from 3 to 10 feet or more in short distances. Angular stones may occur throughout the profile and are scattered on the surface. Rock outcrops are common on the stronger slopes.

Use and management.—About 60 percent is under cultivation and produces satisfactorily the ordinary crops of the region. It is considered especially desirable for garden crops and strawberries.

Skamania very fine sandy loam, 15 to 30 percent slopes (Sn).—This soil is very similar to Skamania very fine sandy loam, 2 to 15 percent slopes, but it is steeper. It occurs mostly in small scattered areas on the lower parts of slopes near the Columbia River and covers a very limited acreage.

Use and management.—About 40 percent of the acreage is under cultivation, mostly to pasture and some hay crops. Owing to the rather steep slopes, the soil needs to be carefully protected against erosion and should be used only for perennial crops that require infrequent plowing.

Skamania very fine sandy loam, 30 to 40 percent slopes (Sp).—This soil is similar to more gently sloping areas of Skamania very fine sandy loam but is more stony and has more rock outcrops. A small area has been cleared for pasture, but none is cultivated. This soil would erode rapidly if cultivated; consequently, it is considered nonagricultural and should be used only for timber.

Stabler shotty loam, 0 to 2 percent slopes (Sq).—This well-drained brown shotty soil occupies high river terraces. The soil was derived from mixed materials dominated by basalt, sandstone, shale, and pumice. It differs from the Felida soils in occurring in areas of greater rainfall and cooler climate and in having developed from materials considerably influenced by pumice. The native vegetation consists of Douglas-fir (pl. 3, *B*), hemlock, some cedar, maple, alder, and an undercover of brush and shrubs. Internal drainage is medium. Areas are mapped in the upper end of the Wind River Valley in association with Stabler shotty loam, 2 to 6 percent slopes.

This soil, one of the most shotty in the area, has a brown granular surface soil that is dark brown when moist. Without the shot, the

texture appears to be a silt loam. The structure is strong and medium granular, and the many durable structural aggregates make the soil seem more shotty than it actually is. The number of shot begins to decrease at about 8 to 10 inches.

Below 12 to 14 inches is light yellowish-brown loam to silt loam containing some shot. This material breaks into subangular blocky aggregates which are slightly hard when dry and friable when moist. Some pumice and light-gray sand particles appear in this layer. Below 40 inches is very pale-brown pumicy loam. It is less dense than the layer above but is blocky in structure and crumbles easily. Below 52 inches the layer may be nearly all pumice, or pumice may be only a small part of the material.

Variations in the profile are chiefly in the quantity of pumice. In some areas there is very little evidence of pumice. Generally, however, it is scattered throughout the profile, especially in the upper part. In places it may occur in layers below 4 feet.

Use and management.—Most areas of this soil are in Gifford Pinchot National Forest, but some are privately owned. Most areas have been logged, but some virgin stands of Douglas-fir remain. Very little has been entirely cleared, but a considerable acreage of brushy and partly timbered land is used as pasture. The raising of livestock and the growing of hay and forage crops are the principal farming enterprises. Crop yields are good. Farming, however, is largely a part-time occupation. In the Gifford Pinchot National Forest a tract is used for propagating forest tree seedlings and for experimental investigations.

Stabler shotty loam, 2 to 6 percent slopes (Sr).—The chief difference between this soil and Stabler shotty loam, 0 to 2 percent slopes, is its more undulating relief. Most slopes are about 5 percent. The two soils are associated and have similar profile characteristics. The amount of pumice is slightly greater in this soil, however, and the subsoil is more firm or compact.

Use and management.—None of this soil is cultivated. If cleared for farming, it would have the same use and management as Stabler shotty loam, 0 to 2 percent slopes. Most areas are in good second-growth timber, and some are used for experimental forestry plots.

Stevenson clay loam, 2 to 15 percent slopes (St).—This soil is the only Stevenson soil of any agricultural importance. It ordinarily has much less stone in the surface layer than the stony clay loam Stevenson soils. The profile is not so variable, and the thickness of the dark surface soil is fairly uniform in areas where the relief is gently rolling. In general the relief is hummocky, or similar to that of a terminal moraine. An indefinite drainage system has developed. Valleys of the smaller streams are less than 50 feet deep, which is shallow for this region. The native vegetation consists of Douglas-fir and associated trees common to other upland soils. The soil occurs mainly in association with the other Stevenson soils. It is also associated with the Olympic soils, which it joins on the north.

About 1½ inches of organic material covers this soil. The upper part of this material consists of loose brown fir needles, leaves, fern fronds, bark, twigs, and other forest litter; the lower part, fairly well

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decomposed leaf mold of the same origin. The middle part may have many white molds, and the lower part may contain considerable mineral soil.

Below the organic layer is grayish-brown clay loam or silty clay loam that contains a trace of shot and gravel. The soil, as mapped, includes many small areas of surface soil having a gritty silty clay texture. The surface layer is sticky and black when wet and it has a weakly granular structure. Its reaction is medium to strongly acid. The layer is bound with fine roots from trees and shrubs. The organic-matter content is fairly high. At about 9 inches this layer grades into brown to grayish-brown silty clay loam containing many fine roots but having a low organic-matter content. The grayish-brown layer breaks into pea-sized subangular aggregates. A few shot are present in the upper part. The color is dark brown when moist but somewhat gray when dry. Some subangular to slightly rounded pieces of gravel and rock, including andesite, basalt, some quartzite, and granite, are scattered through the entire layer. In cultivated areas the organic layer is mixed with the mineral soil below it. The mixture produces a dark grayish-brown to dark-brown plow layer.

The subsoil between 18 and 36 inches is yellowish-brown to brown silty clay loam or silty clay that contains some subangular gravel and rock. Between 36 and 70 inches is yellowish-brown to brown silty clay containing much greenish and grayish disintegrated and partly decomposed rock. Some fine rust-brown and grayish-brown variegations occur. The color of this lower material varies considerably within short distances. There are layers and pockets of yellowish brown, grayish brown, and reddish brown. The content of rock usually increases with depth.

The substratum, or parent material, consists of mixed boulders, rock fragments, and clay. It slightly resembles glacial till and is landslide and talus material that has broken off the mountains and slid toward the Columbia River. The parent ledges consist of stratified layers of sedimentary rocks, lava, and breccia. The sedimentary rocks are largely somewhat soft conglomerates made up of waterworn andesite, basalt, granite, and metamorphic rocks.

Areas near Cloverdale School have a deeper and nearly stone-free profile resembling that of the Olympic soils, which are adjacent on the north. In places the soil is underlain by gray clayey shale.

Use and management.—Only about 10 percent is under cultivation. The cost of clearing is high, even by the most efficient methods. It is necessary to remove from each acre an average of 25 tons of rock in addition to the stumps, brush, and fallen timber.

The common crops of the region are grown—clover and timothy hay, oat hay, and oats for grain. Very little corn is raised, but a large acreage has been partly cleared for pasture.

Stevenson clay loam, 15 to 30 percent slopes (Ss).—Except for stronger slopes, this soil is similar to Stevenson clay loam, 2 to 15 percent slopes. A few small plots are cultivated, and yields are the same as on Stevenson clay loam, 2 to 15 percent slopes. Owing to its stronger slopes, this soil needs to be carefully protected from erosion and should be used mainly for hay and pasture crops. Many areas are partly cleared for pasture.

Stevenson stony clay loam, 30 to 40 percent slopes (Sx).—This soil occupies steep uplands. It has a peculiar "dumped-in" appearance suggestive of a glacial terminal moraine. There are many steep, narrow, irregular ridges and colluvial slopes.

The parent material consists chiefly of slightly weathered landslide and talus materials that slid down from the higher mountains (pl. 4, *A*) toward the Columbia River, but in part it is glacial in origin. The landslide material came from interstratified layers of sedimentary rock, basalt, andesite, and breccia. The sedimentary rock is largely conglomerate, which is composed of a variety of rocks, including quartzite, granite, and lava. In most places there is no solid rock below the landslide material to a depth of 25 feet or more, but occasionally there are small outcrops.

A 1½-inch layer of brown forest litter grades into dark-brown fairly well decomposed leaf mold. The surface soil below this organic material is dark-gray to dark grayish-brown heavy clay loam containing a trace of shot and much rock and gravel. Numerous stones are scattered over the surface. The rock and gravel are largely rounded or subangular and are chiefly basalt or andesite but include some hard metamorphic and granitic rocks. The texture ranges from gravelly clay loam to silty clay. The soil is sticky and black when wet and breaks into a strong granular structure. It is bound with roots from shrubs and trees, and the organic content is fairly high.

At an average depth of 9 inches the soil is grayish-brown heavy clay loam to clay containing considerable rock and gravel. A trace of shot is in the upper part. The soil is dark grayish brown when moist and grayish brown when dry. There are many roots. It breaks into pea-sized subangular blocky aggregates.

The subsoil between 20 and 40 inches is brown clay loam or silty clay that contains much rock and is variegated with rust brown, grayish brown, and yellowish brown. Green and gray splotches from disintegrated rock are also present. The material breaks into subangular blocky aggregates and is slightly compact. This layer is exceedingly variable in the quantity of stone and degree of mottling. The material below 40 inches is yellowish-brown heavy gritty clay loam that contains much rock in various stages of decomposition and many fine roots, despite the fact that it is relatively hard to penetrate because it is stony. Numerous pockets and layers of grayish-brown and reddish-brown material occur below 40 inches. The reaction is generally strongly acid throughout the profile.

The drainage system is incomplete. A great number of small and large depressions are mostly filled with water. Drainage channels are shallow and indefinite and most lakes do not have outlets. In places streams disappear in depressions and reappear as springs farther down the slope. Surface drainage is rapid except in depressions, and internal drainage is medium. Like other Stevenson soils, this soil was formerly covered with Douglas-fir mixed with some hardwoods and cedar. Areas occur in a belt north of the Columbia River in close association with the other Stevenson soils.

The distribution and the quantity of rock and gravel are exceedingly variable within short distances. In many places there are pockets of rounded gravel and clay up to 2 feet in diameter or tongue-shaped pockets of uniform, small, loose gravel.

Use and management.—Most of the native timber has been cut or destroyed by fire, and a young stand now covers most of the soil. It consists of Douglas-fir, alder, vine maple, Oregon-maple, cedar, dogwood, bracken, Oregon-grape, and other shrubs and hardwoods. None of this soil is cultivated, and it is considered too stony and steep to clear. On most areas 50 tons of rock would have to be removed from each acre before the soil could be plowed. It is more valuable for growing timber than for farming.

Stevenson stony clay loam, 15 to 30 percent slopes (Sv).—The smoother relief is the chief characteristic differentiating this soil from Stevenson stony clay loam, 30 to 40 percent slopes. None of this soil is under cultivation, owing to the excessive number of stones. It is closely associated with the other Stevenson soils.

Stevenson stony clay loam, 2 to 15 percent slopes (Sw).—The soil profile is practically the same as but less variable than that of the predominating Stevenson stony clay loam, 30 to 40 percent slopes. The relief is somewhat hummocky, and surface drainage is slow to medium except in the depressions.

Use and management.—Most areas are covered with young Douglas-fir, alder, and other trees and shrubs. Possibly 5 percent of the total area has been cleared. Clearing is expensive, as more than 50 tons of rock has to be removed from each acre. The soil, however, is fairly productive when cleared. It washes easily and must be protected from erosion when the stronger slopes are cultivated.

Stevenson stony loam, 30 to 70 percent slopes (S2).—This soil is similar to Stevenson stony clay loam, 30 to 40 percent slopes, but it occupies more choppy relief where the slopes are short and steep. The source of the parent material is the same as for the other Stevenson soils. In places, however, the material is not so highly disintegrated or decomposed, and stones and gravel may constitute most of the material throughout the profile. Areas are associated with the other Stevenson soils, and drainage and native vegetation are similar.

This soil has a coarser textured profile than Stevenson stony clay loam, 30 to 40 percent slopes. Forested areas are covered with as much as 1½ inches of organic material. Below the organic layer the surface soil to about 6 inches is stony loam or gravelly clay loam containing a trace of shot. The color is black when moist and dark gray to very dark gray when dry. The surface soil is loosely bound by roots of shrubs, trees, and ferns. It is strongly to medium acid. The organic content is fairly high. In most areas large boulders are scattered thickly over the surface. This material is underlain by dark-gray gravelly loam or gravelly clay loam that contains a trace of shot. The texture varies considerably but is generally sticky or plastic when wet.

At 14 inches this layer passes abruptly into pale-brown to brown gravelly loam or gravelly clay loam that in places has pockets and layers of gravelly sandy loam. The material below 30 inches is very pale-brown to yellowish-brown gravelly loam or gravelly clay loam. The large number of rounded to angular boulders and partly disintegrated rock increases with depth. Fine roots extend to 60 inches or more. The parent material below 60 inches is mainly rock, with gravelly clay loam as interstitial material. It has no regular strati-

fication and appears to be mixed landslide, talus, and colluvial materials. The underlying rock consists of interstratified layers of conglomerate, andesite, basalt, and other sedimentary rocks.

Use and management.—Areas northwest of Bonneville Dam are largely covered with a young growth of alder, maple, ferns, and fair stocking of young Douglas-fir. Northeast of Bonneville Dam the soil is covered with large second-growth Douglas-fir and associated trees. Douglas-fir does not grow so large or so dense as on the less stony Stevenson soils. None of the soil is cultivated at the present time. Owing to the steep relief and stony texture, it is most valuable for timber and recreational purposes.

Stevenson stony loam, 15 to 30 percent slopes (Sy).—Except for the somewhat smoother relief, this soil is similar to the predominating Stevenson stony loam, 30 to 70 percent slopes. None of the soil is under cultivation, and it is best suited to forestry.

Stevenson stony loam, 2 to 15 percent slopes (Sz).—The dark surface layer of this soil is deeper, but otherwise it resembles Stevenson stony loam, 30 to 70 percent slopes. It is an inextensive soil and is not cultivated. Probably 50 tons of rock an acre would have to be removed before cultivation would be possible.

Stevenson soils, 15 to 50 percent slopes (Su).—These undifferentiated soils consist of fairly recent landslide material having indistinct and irregularly defined soil profile layers and constituting several Stevenson soils. Underlying a thin cover of organic material is a dark-gray stony gravelly clay loam or loam surface soil to a depth of 5 inches, and then follows a dark grayish-brown gravelly clay loam or loam to 12 inches.

The subsoil is grayish-brown and yellowish-brown gravelly clay loam interstitial material that continues between the rocks to a depth of 60 inches or more. Many huge boulders up to 20 feet high are scattered over the surface. The depth of soil over the stony material is extremely variable, and in places there is little or no soil. The rock is a lava and sedimentary mixture that includes andesite, basalt, breccia, and conglomerate.

The relief is typically of the landslide type, or choppy and hummocky. There are numerous short 40-percent slopes, and the general slope is about 15 to 20 percent toward the river. High steep cliffs are characteristic at the upper border.

Drainage channels are incipient and indefinite. Small lakes occur in the deeper depressions. A fairly heavy growth of Douglas-fir and other trees covers most areas, but some areas have only a scattering of small scrubby trees and shrubs. Many trees lean downhill because the earth around them has moved down the slopes. Although the timber is small and knotty, it is cut for lumber. These soils are not cultivated; they are valuable only for timber production, watershed protection, and recreational purposes.

Toutle sand, 0 to 3 percent slopes (Tb).—This soil occurs on bottom lands adjacent to stream channels and is subject to overflow during high water. The land is almost level, but many abandoned stream meanders and incipient drainage channels make it hummocky. The soil is derived from a mixture of recently deposited alluvium dominated by glacial materials having a high percentage of

pumice and basalt. Drainage is somewhat excessive except during periods of high water. Owing to the porous substratum, internal drainage is very rapid. The soil occurs only on the bottom lands of the Lewis River.

The 1½-inch cover of organic material grades from brown loose leaves on the surface to dark-brown well-decomposed leaf mold in the lower part. Below this material is a 4-inch layer of grayish-brown to olive-gray loamy fine sand. Because it is stratified, the soil ranges from coarse sand to fine sandy loam within short distances. Areas near the river bank have a coarser texture; those some distance from the river are finer. The color results from the large quantity of pumice. Olive-gray loamy sand containing considerable pumice is at depths of 4 to 24 inches. The sand particles vary from olive and pale olive to yellow and usually have some rust-brown and gray fine mottling. The material is loose, porous, incoherent, and single-grained.

The loamy sand layer passes abruptly to gray sand, gravel, and waterworn boulders. The depth to the gravelly substratum varies from 12 to 72 inches or more within short distances. The substratum contains many glacial boulders carried down during the Cascade glaciation. Rocks are scattered over the surface and may be numerous in places.

Use and management.—The native vegetation consists of Douglas-fir, cedar, and some hemlock, alder, vine maple, white pine, dogwood, yew, cottonwood, willow, and other trees. The scanty undergrowth is usually Oregon-grape, salal, snowberry, and fern. Cedar predominates on the flat areas known as the Big Bottom. Until recently none of the native timber was cut. Now most of the area is cutover and has been left to restock. None is cultivated—the soil is too far from market and too droughty to be valuable for crops.

Toutle gravelly sand, 0 to 3 percent slopes (Ta).—Areas are small and scattered and occur in the Lewis River Valley adjacent to the river and in old abandoned stream channels. The soil resembles Toutle sand but it has a much higher proportion of coarse material. It may be considered intermediate between Toutle sand and Riverwash in character. It is subject to frequent overflow during high water. Cedar, Douglas-fir, alder, cottonwood, willow, and other trees, and a very small growth of underbrush cover this soil. The timber is somewhat sparse, especially in areas of recent deposition.

The soil is covered with 1 to 1½ inches of organic material, which is brown loose forest litter in the upper part and dark-brown partly decomposed leaf mold in the lower part. This material passes sharply to a dark-brown, gray, and yellow mixture of pumice, woody fragments, and some gravel and stones. The surface soil may be loamy sand in some spots and gravel and boulders in others. Gray pumice fragments are scattered over the surface in places.

At an average depth of 6 inches the surface soil is underlain by pale-olive to yellowish-brown stratified sand, gravel, gravelly sand, and waterworn boulders. This layer contains a small quantity of mica, and in the upper part, some pumice. The color is fairly gray in a cut bank. This material is loose, porous, incoherent, and single-grained. Rock increases with depth.

Use and management.—None of this soil is under cultivation. Its chief value is for timber, but only a small area has been logged.

Underwood loam, 2 to 15 percent slopes (Ub).—This residual upland soil occupies rolling relief in the southeastern corner of the county where the annual rainfall does not exceed 35 to 40 inches. Internal drainage is medium. Many of the intermittent streams are indefinite and shallow, and the drainage pattern is difficult to trace during the dry season. The soil has developed in place from weathered lava rock, chiefly basalt or closely related basic igneous rocks. It is closely associated with other Underwood soils. It developed from the same parent material as the Olympic soils, but since the climate under which it developed is less humid, it does not have the same profile characteristics.

The native vegetation consists of Western yellow pine, alder, vine maple, prairie oak, dogwood, wild cherry, elderberry, willow, Douglas-fir, and other trees, and manzanita, blackberry, Oregon-grape, and fern.

Virgin areas are covered with about 1½ inches of organic material that consists of loose fir needles, leaves, and other forest litter in the upper part and fairly well decayed leaf mold containing a small quantity of mineral soil in the lower part. Under this layer the soil passes sharply to a brown loam containing many shot and some angular rock and gravel. The shot are round pellets about 1/10 to ¼ inch in diameter, brown on the outside and reddish brown in the center. Some can be crushed between the fingers, but most of the shot are difficult to cut with a knife. The structure is moderately granular, and the reaction is slightly acid. The surface soil is weakly rootbound, and the organic content is low. In cultivated areas the organic layer has been mixed with the surface soil to form a brown, slightly tinged with red, plow layer.

At 9 inches the surface soil grades somewhat sharply into yellowish-red heavy loam or gritty clay loam containing a few shot and some angular rock and gravel. The consistence is firm to hard when dry and plastic when wet. The material breaks into small fine subangular blocky aggregates. There are many fine roots, and the organic content is low. The color varies from yellowish red when dry to dark reddish brown when moist.

At an average depth of 18 inches the material begins to grade into a slightly lighter yellowish-red or reddish-brown clay loam that contains some angular rock and gravel. It is dark reddish brown when moist. The soil is slightly compact and breaks up into pea-sized subangular blocky aggregates.

Between 40 and 60 inches is the substratum, a yellowish-red or reddish-brown clay loam containing a high proportion of partly disintegrated basalt and angular rock and rock fragments. The purple, black, and greenish spots are from disintegrated basalt. Rock increases with depth. At an average depth of 80 inches the soil grades into darker yellowish-red or yellowish-brown clay loam that forms interstitial material between the rocks. The depth to the rocky substratum, or parent material, varies from 2 to 10 feet or more. The reaction is slightly to medium acid. Plant roots may penetrate more than 60 inches.

Areas of this soil in secs. 15 and 22, T. 3. N., R. 10 E. have terrace-like relief. The soil in these areas has a slightly darker surface soil and a more stony and yellow-colored subsoil than the soil described above. Some included areas have a clay loam surface texture.

Use and management.—The larger trees have been cut, and most of this soil is covered with young forest. Probably 5 to 10 percent is under cultivation. Some of the soil is used for fruit, but most is in hay and pasture. Clover and timothy hay, oat hay, and alfalfa do well. Alfalfa thrives better than clover. Fruit is not so well suited as on Chemawa shotty loam, 5 to 15 percent slopes, which occurs in the same general locality.

Cutover areas have quickly restocked with underbrush and young timber, and erosion is generally too slight to be perceptible. Cultivated areas, however, are more susceptible to erosion than tilled areas of other soils in the region. More than 25 percent of the surface soil has been lost in some cultivated fields; consequently, these areas must be carefully protected by winter cover crops and other conservation measures.

Underwood loam, 15 to 30 percent slopes (Ua).—This soil is similar to Underwood loam, 2 to 15 percent slopes, in all characteristics but relief. Some areas adjacent to Chemawa soils have variable profile characteristics. These border areas include smaller bodies of soils having a surface layer similar to that of the Chemawa soils. They are usually more shotty and friable than the normal Underwood soils. Less than 3 percent of this hilly soil is under cultivation. As erosion is a serious problem on cultivated areas, the soil is better suited to timber.

Underwood stony loam, 30 to 70 percent slopes (Ue).—This soil differs from the Underwood loam soils, with which it is closely associated in the southeastern part of the county, mainly in containing more of angular basaltic rock and in having a stronger slope. The difference in elevation between upper and lower slopes ranges from 100 to about 1,000 feet. Surface drainage is rapid and internal drainage is medium.

The profile on the steeper slopes is, in many places, shallow to the rocky substratum. Rock outcrops are more frequent than on Underwood loam soils. Basaltic rocks are scattered over the surface in variable quantities. This soil has developed on low, rounded mountains dissected by V-shaped canyons. The same native vegetation existed on this soil as on the Underwood loam soils.

A 1-inch layer of organic material covers virgin areas of this soil. Leaves, fir needles, moss, and other forest litter compose the upper part, and fairly well decomposed leaf mold the lower. This material is underlain by brown weakly granular loam that is more than 25 percent shot and has a high percentage of stones and rock fragments. This layer is plastic when wet and has a reddish hue. It is slightly to medium acid and has a low organic-matter content. Under this layer is a yellowish-brown to reddish-brown heavy loam containing numerous shot, angular rock fragments, and stones.

Between 16 and 24 inches the subsoil is lighter colored reddish-brown to yellowish-brown clay loam or heavy loam containing much

angular rock and rock fragments. A few shot may be found in the upper part. From 24 to 36 inches is friable yellowish-brown clay loam that contains a large quantity of rock and that becomes more yellow in the lower part. The lower subsoil is lighter yellowish-brown to reddish-brown clay loam that occurs as interstitial material between the rocks. This soil is hard to penetrate because it has a high content of angular, disintegrated andesite or basalt rock. Bedrock occurs at 5 to 10 feet or more. In places, however, it outcrops or is within 12 inches of the surface. The thickness of the soil layers varies according to the depth to the rocky substratum.

Use and management.—A heavy stand of young Western yellow pine, Douglas-fir, and some cedar covers large areas. Alder, maple, willow, and other hardwoods comprise the thick undergrowth. None of this soil is cultivated, because it is too steep and too stony. As underbrush and fallen logs make grazing difficult, pasture is impractical. Timber production is the best use.

Underwood stony loam, 15 to 30 percent slopes (Uc).—Although distinguished from Underwood stony loam, 30 to 70 percent slopes, by its milder relief, this soil is similar in profile and other features. It occurs in small scattered areas and is not cultivated. It is mostly covered with Western yellow pine, Douglas-fir, cedar, alder, and other trees and shrubs.

Underwood stony loam, 2 to 15 percent slopes (Ud).—This soil occurs chiefly on slightly eroded benchlike areas and closely resembles Underwood stony loam, 30 to 70 percent slopes, except in slope and subsoil color, which is less red and more yellowish brown.

The vegetation consists of young Western yellow pine, Douglas-fir, alder, and other trees, and shrubs. Small areas have been partly cleared for pasture. The slopes are favorable for farming, but the large quantity of rock that has to be removed before the soil can be cropped—100 tons an acre—makes cultivation impractical.

Wapato clay loam, 0 to 3 percent slopes (Wa).—This dark grayish-brown soil occurs in nearly level depressions in association with Chehalis soils. It has developed from alluvial or lacustrine material derived from basalt and andesite rock. Drainage is poor. The vegetation consists of alder, willow, Douglas-fir, cedar, oak, maple, skunk-cabbage, devilsclub, nettle, wild rose, fern, sedge, flowering plants, and other trees and shrubs. Small isolated depressional areas of Olympic soils are included with this inextensive soil.

The surface soil of dark-gray clay loam extends to about 7 inches. The organic content is high, and the soil is dark grayish-brown to nearly black when moist. A 2- or 3-inch layer of organic muck covers the surface in places. The reaction is medium to strongly acid. The subsoil between 7 and 30 inches is light brownish-gray to grayish-brown silty clay loam or silty clay that contains much rust-brown and light-gray mottling. When wet the soil has a plastic consistence. The material between 30 and 60 inches is grayish-brown clay highly mottled with rust brown, gray, and yellow and plastic when wet. It dries out to light grayish brown. Thin layers of fine sand may be found at any depth.

Use and management.—This soil is used chiefly for wooded pasture. Partly cleared areas that have been drained provide excellent pasture. Small areas are cultivated, mainly to hay and pasture crops. The soil needs drainage. All but a few areas in deep depressions can be drained fairly easily by ditches.

Washougal loam, 0 to 3 percent slopes (Wb).—This dark-colored soil occupies gravelly stream terraces in association with Bonneville stony loam. It differs from the Bonneville soil in having a dark surface soil 15 to 24 inches thick and a less stony and gravelly substratum. The soil down to the gravelly substratum is friable, and the compaction that occurs in places in the Bonneville soil is absent. Surface drainage is slow; internal drainage, somewhat excessive. The vegetation was originally Douglas-fir and associated trees and shrubs.

This soil is covered by a thin layer of organic material. The surface soil is granular dark grayish-brown to dark-gray heavy loam that contains a few shot and some gravel in places. It is medium to strongly acid. At 12 to 14 inches the surface soil grades into dark-brown to grayish-brown heavy loam that contains a small quantity of gravel. This layer has a grayish hue, becomes lighter in color with depth, and includes some clay loam and gravelly loam. Variegated grayish-brown and gray loose stratified gravel, sand, and boulders and some fine interstitial material occurs at an average depth of 20 inches. The color is mixed with grayish brown and rust brown and some greenish brown from decayed basalt. A few basalt and andesite rocks may be scattered over the surface.

Use and management.—The Douglas-fir timber has been cut. Most areas are now covered with young Douglas-fir, alder, and other trees and brush. Small tracts have been cleared for pasture, but few have been cultivated. The soil would probably be fairly productive if cultivated, but the gravelly substratum would cause crops to suffer from drought during dry summers unless irrigated.

Washougal loam, seeped, 0 to 3 percent slopes (Wc).—This soil is similar to Washougal loam, 0 to 3 percent slopes, but it occurs in slight depressional areas adjacent to steep slopes; consequently, drainage is restricted. The surface, except where artificially drained, is usually covered with water after heavy winter rains. The native vegetation is alder, vine maple, Oregon-maple, cedar, Douglas-fir, hemlock, dogwood, elderberry, and other trees and shrubs. This inextensive soil occurs in isolated areas, mainly on the terraces of the Washougal River, in association with Washougal loam, 0 to 3 percent slopes, and Bonneville stony loam, 0 to 5 percent slopes.

The 15-inch surface soil is dark grayish-brown to black heavy loam. It is covered by a ½-inch layer of partly decayed organic material. The surface soil is rootbound, has a high organic-matter content, and contains a small quantity of gravel. The reaction is medium acid. The subsoil between 15 and 26 inches is a grayish-brown loam that contains considerable gravel and many roots and shows a trace of fine rust-brown and gray mottling. The substratum between 26 and 60 inches consists of yellowish-brown to brown gravelly sandy loam and waterworn boulders. The depth to the substratum ranges from 16 to 36 inches. The rock consists mostly of mixed lava rock and some granite.

Small areas with clay loam surface texture are included. An inclusion on the Lewis River has an 8-inch dark-brown loam surface soil underlain by grayish-brown gravelly sandy loam containing some rust-brown and yellow mottling and some pumice gravel. At a depth of about 20 inches this material is underlain by brownish-gray firm gravelly sandy loam.

Use and management.—Much of this soil has been partly cleared for pasture and is well suited to such use. It is fairly productive when drained.

Wind River gravelly loam, 2 to 5 percent slopes (Wd).—This soil occurs on nearly level to gently sloping river terraces well elevated above the present flood plain. A few included areas have slopes up to 10 percent. The parent material is old alluvium derived mainly from basaltic rock. The gravelly substratum is characteristically composed of subangular, fine, fairly uniform pieces of gravel, many of which are flat. Surface drainage is slow; internal drainage is rapid because of the porous gravelly substratum. This soil was formerly covered with a heavy stand of Douglas-fir, some cedar, alder, and other trees and underbrush. Areas occur principally near Carson and are associated with other Wind River and Riffe soils. The Wind River soils differ from the Riffe soils in having gravelly substrata and slightly darker surface soils.

The grayish-brown to brown gravelly loam surface soil contains much shot to a depth of about 12 inches. It is nearly black to dark grayish brown when moist. Timbered areas are covered with about 1½ inches of organic material, and the upper 2 inches of the mineral soil is relatively dark. This layer is strongly acid and is slightly plastic when wet.

The subsoil, from about 12 to 26 inches, is gravelly loam ranging from brown to yellowish brown when dry and from dark grayish brown to dark brown when moist. This layer is friable when moist and slightly plastic when wet. It is finer textured than the surface soil.

Between 26 and 48 inches is dark yellowish-brown to dark-brown gravelly sandy loam. This lower subsoil is underlain by yellowish-brown stratified gravel, sand, and gravelly sandy loam that contain some waterworn boulders and extend deeper than 30 feet in most places. The gravel and rock consist mostly of basalt and are subangular to slightly rounded. The lower subsoil and substratum are strongly acid.

Use and management.—About 50 percent of this soil is under cultivation. The rest is partly covered with young Douglas-fir and other trees. Some areas are denuded of timber and are used in part for wooded pasture. Clover, timothy, and oats occupy the largest cultivated areas. Small areas are used for apples, prunes, and truck crops, which do well. The soil becomes fairly dry in the latter part of the growing season.

Wind River gravelly loam, 15 to 30 percent slopes (We).—This soil is similar to Wind River gravelly loam, 2 to 5 percent slopes, except that is is more variable in depth and generally not so deep to the gravelly substratum. The surface texture ranges from gravelly sandy loam to gravelly loam. The soil is too droughty and hilly for crops, and none is cultivated. It is considered more valuable for timber.

Wind River gravelly loam, 30 to 70 percent slopes (Wf).—Areas of this soil occupy precipitous slopes or steep terrace breaks, mainly along the Wind River. The soil is similar to Wind River gravelly loam, 2 to 5 percent slopes, but the texture of the surface soil is variable, ranging from gravelly clay loam to gravelly sandy loam. The surface soil is usually shallow, and the depth to the gravelly substratum generally not more than 20 inches. The soil is nonagricultural and is in timber and brush. It has considerable value as a source of commercial gravel and sand.

Wind River loam, 2 to 5 percent slopes (Wg).—This inextensive soil resembles Wind River gravelly loam, 2 to 5 percent slopes, except that it does not have so much gravel in the surface soil. It is closely associated with the Wind River gravelly loam soils and occurs mainly in small areas.

The surface soil is dark grayish-brown loam that has a silty texture to 2 or 3 inches, and then is dark-brown loam to about 12 inches. It contains much fine silt, but the many broken shot give it a gritty feel. The structure is weakly granular, and the organic-matter content is moderate. In timbered areas the surface soil is rootbound by trees and shrubs. The reaction is strongly acid in areas near the Wind River and slightly acid in areas north of Underwood.

Between 12 and 18 inches the soil is brown to dark yellowish-brown silt loam containing some shot. This layer passes sharply to yellowish-brown slightly compact silt loam that contains some gravel. At 24 inches the soil is yellowish-brown or brownish-yellow gravelly silt loam or loam that contains much very fine sand. It becomes coarser with depth. At an average depth of 36 inches the soil is irregularly stratified yellowish-brown to grayish-brown gravelly sandy loam or sand and gravel. The depth to the coarse substratum ranges from 2 to 4 feet. The substratum extends to 6 to 40 feet, where it is underlain by stony clay loam and basalt rock. Fine roots extend farther than 36 inches.

Use and management.—A heavy stand of Douglas-fir, a few cedars, and alders, and an undergrowth of salal and Oregon-grape formerly covered this soil. Most areas are now under cultivation or in pasture. Several small orchards of Italian prunes, Barcelona and Du Chilly filberts, and apples have been established, but little fruit has been harvested. The prunes suffer from drought in dry summers. Clover, timothy, and oats for hay (pl. 4, *B*) do well. The soil responds well to commercial fertilizers, especially phosphorus and nitrogen.

Wind River loam, 15 to 30 percent slopes (Wh).—This soil is similar to the predominating Wind River loam, 2 to 5 percent slopes, but the surface soil contains a small quantity of gravel and the subsoil is more variable in texture. About 30 percent of this inextensive soil is under cultivation, and yields approximate those on the gently sloping areas. The uncleared areas are covered with young Douglas-fir.

CAPABILITY GROUPS OF SOILS

The capability grouping is an arrangement of soils to show relative suitability for tilled crops, forage, forestry, wildlife, watersheds, or

recreation, and the risk of erosion or other damage. It is widely used to help farmers plan their practices for soil and water conservation.

Eight broad classes are provided in the capability arrangement, although not all classes are in Skamania County. Each soil is placed in one of these eight classes after joint study by several persons who have knowledge of the soils and agriculture of the area.

Soils that are easy to farm and that have no serious limitations for use are placed in class I. Such soils are not subject to erosion, drought, wetness, or other limitations and are at least fairly fertile. They are good for many uses. The farmer can use his class I soils for crops without special practices, other than those needed for good farming anywhere, and can choose one of several cropping patterns; or if he wishes he may use the soil for pasture, trees, or for other purposes.

Soils are placed in class II if they are a little less widely adaptable, and thus more limited, than those in class I. For example, a gently sloping soil may have a slight erosion hazard so that it requires contour farming or other practices to control runoff. Other soils may be placed in class II because they are too droughty or too shallow to be in class I.

Class III contains the soils that are suitable for regular cropping but that have narrower adaptations for use or more stringent management requirements than those in class II. The soils that are even more limited and that have narrower crop adaptations than those in class III but that are still suitable for tillage part of the time, or with special precautions, are placed in class IV.

Soils not suitable for cultivation, or on which cultivation is not advisable, are placed in classes V, VI, VII, and VIII. Class V consists of soils not subject to erosion but unsuited to cultivation because of standing water or frequency of overflow. Class VI contains soils that may be steep, droughty, or shallow but that will produce fairly good amounts of forage, orchard fruits, or forest products. As a rule class VI soils should not be cultivated, but some of them can safely be disturbed to prepare for planting trees or seeding extremely long-producing forage crops.

Soils in class VII are more limited than those in class VI. They usually give only fair to poor yields of forage or wood products. Class VIII consists of soils so severely limited that they produce little useful vegetation. They may make attractive scenery or may be parts of useful watersheds. Some may have value as wildlife habitats.

Subclasses: Although the soils within a single capability class have limitations, and therefore use and management problems of about the same degree, the kinds of problems may differ greatly. Class III in Skamania County, for example, includes some well-drained erodible soils, some excessively drained droughty soils, and some poorly drained soils limited chiefly by excess water. Capability subclasses are used to indicate the dominant kind of problem. The subclasses used in Skamania County according to dominant limitations are: Erosion, designated by the symbol (e), excess water (w), and shallow, infertile or droughty soils (s). Subclasses are denoted by the small letter that follows the class number, such as IIe, IIIw, IVe, and so on in the list that follows.

CAPABILITY CLASSES AND SUBCLASSES FOR SOILS OF SKAMANIA COUNTY

	Capability class and subclass
Bear Prairie clay loam, 15 to 30 percent slopes (Ba)	VIe.
Bear Prairie clay loam, 5 to 15 percent slopes (Bb)	IVe.
Bear Prairie clay loam, 2 to 5 percent slopes (Bc)	IIIs.
Bonneville stony loam, 0 to 5 percent slopes (Bd)	IVs.
Burlington fine sand, 2 to 5 percent slopes (Be)	IIIs.
Burlington fine sand, 15 to 30 percent slopes (Bf)	VIe.
Chehalis silty clay loam, 0 to 3 percent slopes (Ca)	IIs,
Chemawa shotty loam, 15 to 30 percent slopes (Cb)	IVe.
Chemawa shotty loam, 5 to 15 percent slopes (Cc)	IIIe.
Chemawa shotty loam, 30 to 40 percent slopes (Cd)	VIe.
Chemawa shotty loam, 2 to 5 percent slopes (Ce)	IIe.
Columbia fine sand, 0 to 3 percent slopes (Cf)	IIIs.
Columbia gravelly sand, 0 to 3 percent slopes (Cg)	VIs.
Columbia loam, 0 to 3 percent slopes (Ch)	IIs.
Cougar gravelly sandy loam, 2 to 5 percent slopes (Ck)	VIs.
Felida clay loam, 15 to 30 percent slopes (Fa)	IVe.
Felida clay loam, 5 to 15 percent slopes (Fb)	IIIs.
Felida loam, 5 to 15 percent slopes (Fc)	IIIe.
Felida silt loam, 5 to 15 percent slopes (Fd)	IIIe.
Felida silt loam, 15 to 30 percent slopes (Fe)	IVe.
Felida silt loam, 30 to 40 percent slopes (Ff)	VIe.
Greenwater gravelly sand, 2 to 5 percent slopes (Ga)	VIs.
Greenwater gravelly sand, 15 to 35 percent slopes (Gb)	VIs.
Greenwater gravelly sandy loam, 2 to 5 percent slopes (Gc)	IVs.
Hesson clay loam, 15 to 30 percent slopes (Ha)	VIe.
Hesson clay loam, 5 to 15 percent slopes (Hb)	IVe.
Hesson clay loam, 30 to 40 percent slopes (Hc)	VIIe.
Hillsboro fine sandy loam, 15 to 30 percent slopes (Hd)	IVe.
Hillsboro fine sandy loam, 5 to 15 percent slopes (He)	IIIs.
Hillsboro fine sandy loam, 30 to 40 percent slopes (Hf)	VIIe.
Hood silt loam, 15 to 30 percent slopes (Hg)	VIe.
Hood silt loam, 2 to 15 percent slopes (Hh)	IVs.
Hood silt loam, 30 to 40 percent slopes (Hk)	VIIe.
Lava flows, 15 to 30 percent slopes (La)	VIII.
Made land (Ma)	VIII.
Martha clay loam, 0 to 3 percent slopes (Mb)	IIIw.
Nesika gravelly loam, 2 to 5 percent slopes (Na)	IIs.
Newberg fine sandy loam, 0 to 3 percent slopes (Nb)	IIIw.
Olympic clay loam, 15 to 30 percent slopes (Oa)	VIe.
Olympic clay loam, 2 to 15 percent slopes (Ob)	IVs.
Olympic clay loam, 30 to 70 percent slopes (Oc)	VIIe.
Olympic stony clay loam, 15 to 30 percent slopes (Od)	VIe.
Olympic stony clay loam, 2 to 15 percent slopes (Oe)	VIs.
Olympic stony clay loam, 30 to 60 percent slopes (Of)	VIIe.
Olympic stony loam, 15 to 30 percent slopes (Og)	VIe.
Olympic stony loam, 2 to 15 percent slopes (Oh)	VIe.
Olympic stony loam, 30 to 70 percent slopes (Ok)	VIIe.
Riffe fine sandy loam, 3 to 15 percent slopes (Ra)	IVs.
Riffe fine sandy loam, 0 to 3 percent slopes (Rb)	IIIs.
Riverwash, 0 to 5 percent slopes (Rc)	VIII.
Rock outcrop, 50 to 70 percent slopes (Rd)	VIII.
Rough broken land, 30 to 70 percent slopes (Re)	VIIe.
Rough mountainous land, 50 to 60 percent slopes (Rf)	VIIe.
St. Helens pumicy sandy loam, 15 to 30 percent slopes (S)	VIe.
St. Helens pumicy sandy loam, 2 to 15 percent slopes (Sa)	VIs.
St. Helens pumicy sandy loam, 30 to 70 percent slopes (Sb)	VIIe.
St. Martin clay loam, 15 to 30 percent slopes (Sc)	VIe.
St. Martin clay loam, 2 to 15 percent slopes (Sd)	IVe.
St. Martin clay loam, 30 to 40 percent slopes (Se)	VIIe.
St. Martin stony clay loam, 15 to 30 percent slopes (Sf)	VIe.
St. Martin stony clay loam, 2 to 15 percent slopes (Sg)	VIe.

CAPABILITY CLASSES AND SUBCLASSES FOR SOILS OF SKAMANIA COUNTY—Continued

	Capability class and subclass
St. Martin stony clay loam, 30 to 50 percent slopes (Sh)	VIIe.
Semiahmoo muck, 0 to 2 percent slopes (Si)	IIIw.
Semiahmoo muck, shallow, 0 to 2 percent slopes (Sj)	IIIw.
Skamania silt loam, 15 to 30 percent slopes (Sk)	IVe.
Skamania silt loam, 2 to 15 percent slopes (Sl)	IIIs.
Skamania silt loam, 30 to 40 percent slopes (Sm)	VIIe.
Skamania very fine sandy loam, 15 to 30 percent slopes (Sn)	IVe.
Skamania very fine sandy loam, 2 to 15 percent slopes (So)	IIIs.
Skamania very fine sandy loam, 30 to 40 percent slopes (Sp)	VIIe.
Stabler shotty loam, 0 to 2 percent slopes (Sq)	IIs.
Stabler shotty loam, 2 to 6 percent slopes (Sr)	IIIs.
Stevenson clay loam, 15 to 30 percent slopes (Ss)	VIe.
Stevenson clay loam, 2 to 15 percent slopes (St)	IVs.
Stevenson soils, 15 to 50 percent slopes (Su)	VIIe.
Stevenson stony clay loam, 15 to 30 percent slopes (Sv)	VIe.
Stevenson stony clay loam, 2 to 15 percent slopes (Sw)	IVs.
Stevenson stony clay loam, 30 to 40 percent slopes (Sx)	VIIe.
Stevenson stony loam, 15 to 30 percent slopes (Sy)	VIe.
Stevenson stony loam, 2 to 15 percent slopes (Sz)	IVs.
Stevenson stony loam, 30 to 70 percent slopes (S2)	VIIe.
Toutle gravelly sand, 0 to 3 percent slopes (Ta)	VIs.
Toutle sand, 0 to 3 percent slopes (Tb)	VIs.
Underwood loam, 15 to 30 percent slopes (Ua)	VIe.
Underwood loam, 2 to 15 percent slopes (Ub)	IIIs.
Underwood stony loam, 15 to 30 percent slopes (Uc)	VIe.
Underwood stony loam, 2 to 15 percent slopes (Ud)	IVe.
Underwood stony loam, 30 to 70 percent slopes (Ue)	VIIe.
Wapato clay loam, 0 to 3 percent slopes (Wa)	IIIw.
Washougal loam, 0 to 3 percent slopes (Wb)	IVs.
Washougal loam, seeped, 0 to 3 percent slopes (Wc)	IIIw.
Wind River gravelly loam, 2 to 5 percent slopes (Wd)	IVs.
Wind River gravelly loam, 15 to 30 percent slopes (We)	VIe.
Wind River gravelly loam, 30 to 70 percent slopes (Wf)	VIIe.
Wind River loam, 2 to 5 percent slopes (Wg)	IVs.
Wind River loam, 15 to 30 percent slopes (Wh)	VIe.

AGRICULTURE

The early explorers of the area reported large Indian settlements along the Columbia River, especially near the Cascades at what is now North Bonneville. The Indians, who had partly cleared this locality of trees by burning, lived on fish and game but grew a small quantity of tobacco. These cleared areas later provided grazing for the horses and cattle of the early settlers.

The first permanent white settlers began to arrive about 1849. They were employed at cutting wood and lumber and in river transportation, but they grew fruits and vegetables for home use and cut some native grass for hay.

The cleared area has increased slowly. In 1950, 24,921 acres was reported on farms. Only 5,842 acres, however, was classified as cropland.

LAND USE

Only 2.3 percent of the county was in farms in 1950. The rest was in forest, including the Gifford Pinchot National Forest. Land in farms, according to the 1950 census, totaled 24,921 acres, which was divided as follows: Cropland harvested, 3,032 acres; cropland not

harvested and not pastured, 1,284; plowable pasture, 1,526; woodland, 14,827; and all other farmland, 4,207 acres.

Agricultural land in the county is extremely limited because of the rough broken topography and stoniness of many of the soils. Most of the cultivated land occurs in the southeastern and southwestern parts of the county and is restricted to terraces and benchlike areas along the Columbia, Little White Salmon, Washougal, and Wind Rivers. The principal soils in these areas are the Chemawa, Hillsboro, Felida, Skamania, Riffe, and Wind River. The farms having the highest proportion of improved land are usually on Chemawa and Wind River soils. These soils grow most of the fruits and nuts in the county.

The pasture and hay crops are grown mostly on Felida, Hillsboro, Skamania, and Columbia soils. Alfalfa does well on the deep friable soils of river terraces. Farmland that is not cropped is used mainly for wooded pasture and forest. Many farmers in the western part of the county depend upon outside work for part of their income. Land not in farms is used almost exclusively for forestry, but a small part is barren of vegetation and nonproductive of any plants.

CROPS

Fruit and hay are the principal crops in the county. In 1949, 1,981 acres was used for hay crops, of which timothy and clover, alfalfa, and grains cut green were the most important. Pears, apples, and nuts were the chief tree crops. Harvesting fruit usually employs the only transient labor in the county. Farm labor for planting and harvesting other crops is hired locally.

The acreage of the principal crops and the number of bearing fruit trees and grapevines are listed in table 5 for stated years.

ROTATIONS AND FERTILIZERS

Crops are not rotated systematically in Skamania County. Unless specialized crops such as fruits and nuts are grown, however, some system of crop rotation and fertilization is practical and essential to maintain the fertility of the soils. Rotations on livestock farms are simple and consist chiefly of 2 or 3 years of pasture and hay crops followed by a cultivated crop such as corn or oats. Hay crops usually consist of legume-grass mixtures.

Little if any commercial fertilizer is used on hay and forage crops. Apple and pear orchards receive most of the commercial fertilizer used in the county. Ammonium sulfate, the most commonly used fertilizer, is generally applied at the rate of 5 pounds a tree. Small quantities of nitrate of soda and other fertilizers are also used. Green-manure crops offer a most successful and economical way of maintaining soil fertility. All available manure is usually applied to help maintain the nitrogen supply and organic-matter content of the soils. Use of liming materials is limited because their cost is high and because experiments have not been made to determine how they can be used properly.

TABLE 5.—*Acreage of the principal crops and number of bearing fruit trees and grapevines in Skamania County, Wash., in stated years*

Crop	1919	1929	1939	1949
	Acres	*Acres*	*Acres*	*Acres*
All hay	2,429	1,962	2,745	1,981
Grains cut green	586	647	892	331
Timothy and clover	1,255	512	665	580
Alfalfa	105	180	392	349
Annual legumes	28	10	72	[1]
Other tame hay	290	332	556	577
Wild hay	165	281	168	144
Oats:				
Threshed	418	332	67	138
Unthreshed	[1]	253	34	64
Corn:				
For grain	98	70	52	13
For silage	37	95	94	44
For all other purposes	[1]	65	59	3
Wheat	15	10	22	52
Potatoes for home use or sale	189	153	50	[2] 2
Strawberries	47	106	22	11
	Number	*Number*	*Number*	*Number*
Apple trees	26,889	23,782	17,010	10,496
Prune and plum trees	6,969	11,932	8,007	2,046
Pear trees	5,508	8,941	13,994	15,302
Cherry trees	1,382	2,158	1,378	508
Peach trees	1,134	471	291	200
Apricot trees	1	5	28	70
Filbert and walnut trees	1,118	4,325	5,919	3,115
Grapevines	893	924	780	675

[1] Not reported.
[2] Does not include acres for farms with less than 10 bags harvested.

LIVESTOCK AND LIVESTOCK PRODUCTS

Most of the livestock in the county are cattle, principally mixed dairy breeds. Other livestock are goats, hogs, horses, and sheep. Farmers usually raise enough feed and hay for their stock, but some grain feed is purchased. The most important pastures occur on the Columbia soils in partly cleared areas. Farms having livestock and livestock products as their principal source of income are located largely in the western half of the area on river terraces, including the old eroded river terraces of the Hesson soils. Until 1929 most of the dairy products were sold in the form of cream. Since the establishment of milk routes for daily collection, however, dairy products are sold primarily as whole milk.

Poultry and poultry products are important in the county. In 1950, 7,892 chickens over 4 months old were on farms. Three farms reported raising 1,132 turkeys in 1949.

The number of livestock on farms in stated years is shown in table 6.

TABLE 6.—*Number of livestock of all ages on farms in Skamania County, Wash., in stated years*

Livestock	1920	1930	1940	1950
	Number	*Number*	*Number*	*Number*
Horses	456	277	[1] 248	116
Mules	32	14	[1] 14	5
Cattle	1, 712	1, 353	[1] 1, 633	1, 864
Hogs	569	396	[2] 383	239
Goats	114	325	[2] 270	([3])
Sheep	806	2, 686	[4] 309	101
Chickens	9, 000	[1] 8, 952	[2] 11, 274	[2] 7, 892

[1] Over 3 months old.
[2] Over 4 months old.
[3] Not reported.
[4] Over 6 months old.

TYPES AND SIZES OF FARMS

In 1950, 21 farms in the county were classified as livestock farms, 21 as poultry farms, 21 as dairy, 4 as general, 4 as vegetable, 4 as fruit and nut, and 164 farms were not classified.

The 239 farms covered a total of 24,921 acres in 1950, an average of 104.3 acres a farm. The acreage of improved land on each farm averaged 24.4, or a total of 5,842 acres for all farms. Almost three-fourths of the farms in the county in 1950 had less than 100 acres, and about half had less than 50 acres.

FARM TENURE

Owners and part owners operated 224 farms in 1950, tenants operated 14, and managers only 1. The number of farms operated by owners and part owners in 1950 represented about 94 percent of the total, as compared with 87 percent of the total in 1920. Tenant operation decreased from 12 percent of the farms in 1920 to 6 percent in 1950. Most of the tenants rent land on a cash basis.

ADDITIONAL FACTS ABOUT SKAMANIA COUNTY

ORGANIZATION AND POPULATION

Skamania County was first organized as part of the Oregon Territory in 1854 and extended east to Idaho and north to Canada (*2*, *5*). The boundaries were changed in 1867, 1869, 1879, and to their present limits in 1881.

The recorded history of the area dates from the exploration of the Columbia River by Lewis and Clark in 1805. The region was dominated by traders of the Hudson's Bay Company until 1833. In 1846 it became a part of the United States and settlement began. The chief occupations of the early settlers were navigation of the Columbia River and lumbering. Timber from the area was floated from below North Bonneville down the Columbia River because logs could not be floated over the rapids at North Bonneville.

The Indians massacred about a third of the white people near North Bonneville in 1865, but Federal troops soon made the area safe for settlers.

The population of the county increased from 2,891 in 1930 to 4,788 in 1950. The construction of the Bonneville Dam was directly responsible for many new people coming into the county. The majority of the inhabitants are native-born, largely of old American stock and British descent. About 10 percent trace their origin to Scandinavian countries, another 10 percent to Germany, and 7 percent to other European countries. Except for a settlement at Hemlock, practically none of the people in the county live inside the Gifford Pinchot National Forest.

Stevenson, the county seat, had a population of 584 in 1940; North Bonneville, 564. These are the only incorporated towns, but other important communities are Carson, Skamania, and Underwood.

INDUSTRIES

Logging is the most important industry in the county. Many small sawmills are scattered throughout the area, but most of the logs are hauled to the Columbia River and floated to large sawmills near Vancouver, Wash., and Portland, Oreg. There is a vast acreage of timber in the Gifford Pinchot National Forest, within the county but outside the area surveyed. Much of the virgin timber outside the Gifford Pinchot National Forest has been cut. The logging of second-growth timber for poles and piling has increased in recent years. A great many part-time farmers or people who have a few acres of cultivated land are supplementing their income by working in logging and lumbering.

There are many mine prospects for low-grade copper, gold, and silver ore, but no mining was being done at the time of this survey.

TRANSPORTATION

Steamboats provided regular service from The Dalles to Portland by way of the portage railroad until the Spokane, Portland and Seattle Railway was completed in 1908. This railway follows the Columbia River, which forms the southern boundary of the county. It is the principal railroad between Portland and Spokane and connects with the Northern Pacific, Union Pacific, and Great Northern Railroads at Vancouver and Portland. No railroad extends to the interior of the county. Loading stations are at Cape Horn, Skamania, Underwood, and other points. Trains make scheduled stops at Stevenson and North Bonneville for passengers and freight.

Daily scheduled stops are made by passenger buses, which connect with Vancouver to the west and Spokane to the east. The nearest passenger airport is at Portland. River transportation was expanded by the building of the Bonneville Dam and locks in 1937, but the tonnage of river freight is still small and consists largely of logs floated to mills.

The area surveyed is traversed by good highways, including the Evergreen Highway, U. S. No. 830, which follows the Columbia River. Hard-surfaced roads connect most of the settled areas with the main highway. Owing to the mountainous terrain, however, a few of the unsettled areas can be reached only by dirt logging roads and fire-protection trails. County and State roads are in good condition but require constant maintenance because water erosion, slides, and moisture seepage are common in mountainous areas. Public

roads must be hard-surfaced or covered with gravel or crushed rock to be passable in rainy periods during winter.

FARM AND HOME IMPROVEMENTS AND SOCIAL FACILITIES

Most children attend consolidated schools, and bus service is available for all outlying districts. Churches are located in the principal communities.

Telephone service is available to most rural areas, but in 1950 only 65 of the 239 farms reported having telephones. This figure is an estimate for all farms made on the basis of reports from about 20 percent of them. Electricity is also available to most farms, and 255 (based on reports from 20 percent of them) had electric power in 1950. Modern farm conveniences increased sharply after the completion of the Bonneville Dam. Electric power is also furnished by a private power company, which has a dam and power plant on the White Salmon River.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of the environment acting on the soil materials deposited or accumulated by the geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent soil material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the relief, or lay of the land, which determines the exposure to sun, rain, and wind and influences the drainage, moisture content, aeration, and susceptibility of the soil to erosion; (4) the biological forces acting upon the soil material—the plants and animals living upon and in it; and (5) the length of time the climatic and biologic forces have acted on the soil material.

Skamania County is in the northern part of the Middle Cascade section of the Sierra-Cascade physiographic province (*3*), which is characterized by generally accordant summits and higher volcanic cones. This is a region of deeply dissected high mountains characterized by scattered low and high terraces, and in the southern part of the county by benchlike or plateau areas. High mountain ridges extend to the Columbia River, which forms the southern boundary of the county and cuts through the Cascade Mountains from east to west. The Cascade crest, or the summit of the Cascade Mountains, passes through the eastern half of the county in a north-south direction.

The mountainous relief has a marked influence on the climate of the county. At points along the Columbia River the rainfall increases eastward from about 50 to 60 inches in the southwestern part to more than 75 inches near the crest of the Cascades. East of the crest rainfall decreases rapidly to about 35 inches in the southeastern part of the county. Precipitation is progressively higher and temperature lower with increasing altitudes away from the Columbia River. In the mountainous valleys in the interior of the county the annual precipitation is greater than 90 inches. Most of the precipitation falls between October and April; little effective rain falls during summer. The differences of rainfall from west to east in the southern part of the county have a marked influence on the soils.

Except for the area along the Lewis River most of the county has an average winter temperature of about 37° F. and an average summer temperature of about 65°. This climate appears to be very favorable for rapid weathering of rocks and parent materials, as most of the soils are leached to considerable depth.

The area in the county near the Lewis River is colder than the other parts of the county, and most of the soils are podzolic.

The native vegetation of the county is a dense stand of coniferous forest and an undergrowth of shrubs, ferns, and mosses. Deciduous trees and brush are common in depressions and alluvial flood plains. Douglas-fir is the dominant forest type and hemlock is an important associate. Western yellow pine occurs on the eastern slope of the Cascades in the lower rainfall areas, especially on the south slopes in the eastern part of the county. A few local areas are fern and grass prairies relatively free from timber except for scattered Douglas-fir.

The Cascades are composed primarily of Miocene volcanics, dominantly basic igneous with inclusions of a few acid igneous rocks. Most soils have developed in place from andesitic and basaltic rock. Small areas near the Columbia River have developed from old rock slides or talus material consisting of mixed lava rock, breccia, conglomerate, and other rocks, but chiefly basic igneous. Soils of the uplands bordering the Lewis River and near Mount St. Helens have developed from pumice material overlying basic igneous rock. Relatively small areas are developed from recent alluvial sediments and old alluvial and windblown deposits.

The Olympic soils cover most of the surveyed area in Skamania County. The Olympic and many other series in the county have many characteristics of lateritic soils. Most soils of uplands and old terraces have developed under a coniferous forest cover and have a 4- to 6-inch A_1 horizon high in shot (7), and both the A_1 and B horizons have pronounced stable and durable granular or subangular blocky structure. The structural aggregates are very similar to those of lateritic soils. Even though fine-textured, the soils are permeable and only slightly plastic when wet. Most of these soils are deeply weathered like lateritic soils.

The finer textured Olympic, Hesson, and Stevenson soils on the western slope of the Cascades have structural aggregates that are more coarse, angular, and durable than in the slightly coarser textured soils of the Underwood, Chemawa, and Hood series on the eastern and drier slope of the Cascades. All of these soils are friable, permeable, and can be tilled under a wide range of moisture conditions. They have a high absorptive capacity for water, and the normal erosion loss is slight. The organic-matter content is moderate to high but is made up largely of inactive or inert materials, low in bases, which decompose slowly and mix very little with the mineral part of the soil. Most soils have a dark-brown or dark grayish-brown surface soil under virgin conditions and when moist have a slight reddish cast in cultivated fields. The soils in the central part of the county are slightly darker colored than those in the eastern area. Many soils in the county have clay loam textures, but some of the series have a loam or coarser texture.

The color, pH value, and water stability of the aggregates in some of the important soils in the county are shown in table 7.

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TABLE 7.—*Color, pH, and water stability of the aggregates of some of the important soils of Skamania County, Wash.*[1]

Soil and location	Depth in inches	Color [2]		pH [3]	Water stability of aggregates [4]
		Dry	Moist		
Bear Prairie clay loam, 2 to 5 percent slopes (NE¼ sec. 30, T. 2 N., R. 5 E.).	0 to 12	Dark brown (7.5YR 4/2)	Very dark brown (7.5YR 2/2)	6. 0	Very stable.
	12 to 22	Brown (7.5YR 4/2)	Very dark brown (7.5YR 2/2)	5. 3	Very stable.
	22 to 31	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 3/4).	5. 3	Very stable.
	31 to 50	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5. 0	Very stable.
	50 to 60	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 3/4).	4. 5	Very stable.
Bonneville stony loam, 0 to 5 percent slopes (SW¼ sec. 34, T. 2 N., R. 6 E.).	1½ to 0	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	6. 0	Very stable.
	0 to 6	Dark grayish brown (10YR 4/2).	Very dark brown (10YR 2/2)	6. 1	Very stable.
	6 to 9	Dark brown (7.5YR 4/2)	Very dark grayish brown (10YR 3/2).	6. 1	
	9 to 40	Dark brown (10YR 5/3)	Dark brown (10YR 3/3)	6. 1	
Chehalis silty clay loam, 0 to 3 percent slopes (SE¼ sec. 26, T. 2 N., R. 6 E.).	0 to 13	Dark grayish brown (10YR 4/2).	Very dark brown (10YR 2/2)	6. 2	Very stable.
	13 to 31	Dark brown (7.5YR 4/2)	Dark brown (7.5YR 3/2)	6. 2	Very stable.
	31 to 60	Dark brown (10YR 4/3)	Dark brown (10YR 3/3)	6. 2	Very stable.
	60 to 72	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 3/4).	6. 2	Stable.
Chemawa shotty loam, 15 to 30 percent slopes (middle sec. 9, T. 3 N., R. 10 E.).	1½ to 0	Dark grayish brown (10YR 4/2).		6. 0	Very stable.
	0 to 6	Dark brown (10YR 4/3)	Dark brown (10YR 3/3)	6. 3	Very stable.
	6 to 17	Yellowish brown (10YR 5/4)	Dark brown (7.5YR 4/4)	6. 2	Very stable.
	17 to 22	Yellowish brown (10YR 5/4)	Dark brown (7.5YR 4/4)	5. 7	Very stable.
	22 to 40	Yellowish brown (10YR 5/4)	Dark brown (7.5YR 4/4)	[5] 5. 3	Very stable.
	40 to 65	Yellowish brown (10YR 5/6)	Strong brown (7.5YR 4/6)	[5] 5. 0	Very stable.

Chemawa shotty loam, 5 to 15 percent slopes (NE¼ sec. 15, T. 3 N., R. 9 E.).	1½ to 0	Dark grayish brown (10YR 4/2).		6.0	Very stable.
	0 to 3	Brown (10YR 4/3)	Dark brown (10YR 3/3)	6.0	Very stable.
	3 to 11	Brown (10YR 5/3)	Dark brown (7.5YR 3/4)	5.8	Very stable.
	11 to 24	Yellowish brown (10YR 5/4)	Dark brown (7.5YR 4/4)	5.7	Very stable.
	24 to 34	Yellowish brown (10YR 5/4)	Dark brown (7.5YR 4/4)	[5] 5.5	Very stable.
	34 to 72	Light yellowish brown (10YR 6/4).	Yellowish brown (10YR 5/4)	[5] 5.3	Very stable.
Columbia fine sand, 0 to 3 percent slopes (SE corner sec. 19, T. 2 N., R. 7 E.).	1 to 0	Dark grayish brown (10YR 4/2).		6.0	
	0 to 4	Dark grayish brown (10YR 4/2).		6.1	
	4 to 7	Light brownish gray (2.5Y 6/2).	Dark grayish brown (2.5Y 4/2).	6.3	
	7 to 14	Light brownish gray (2.5Y 6/2).	Dark grayish brown (2.5YR 4/2).	6.5	
	14 to 33	Light brownish gray (2.5Y 6/2).	Dark grayish brown (2.5YR 4/2).	6.5	
	33 to 60	Light brownish gray (2.5Y 6/2).	Dark grayish brown (2.5YR 4/2).	6.5	
Columbia loam, 0 to 3 percent slopes (SE¼SE¼ sec. 19, T. 2 N., R. 7 E.).	2 to 0	Very dark grayish brown (10YR 3/2).		6.0	Very stable.
	0 to 4	Dark grayish brown (10YR 4/2).	Very dark brown (7.5YR 2/2)	6.2	Very stable.
	4 to 7	Grayish brown (10YR 5/2)	Very dark grayish brown (10YR 3/2).	6.0	Stable.
	7 to 23	Grayish brown (10YR 5/2)	Very dark grayish brown (10YR 3/2).	5.8	Stable.
	23 to 42	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	6.5	Slightly stable.
	42 to 56	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	6.4	Slightly stable.
Cougar gravelly sandy loam, 2 to 5 percent slopes (sec. 29, T. 7 N., R. 5 E.).	2 to 0	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	4.8	
	0 to 4	Gray (5Y 6/1)	Dark gray (5Y 4/1)	5.0	
	4 to 12	Light olive gray (5Y 6/2)	Dark gray (5Y 4/1)	5.5	
	12 to 66	Light gray (5Y 7/1)	Dark gray (5Y 4/1)	6.0	
	66 to 80	Light gray (5Y 7/1)	Dark gray (5Y 4/1)	6.2	

See footnotes at end of table.

TABLE 7.—*Color, pH, and water stability of the aggregates of some of the important soils of Skamania County, Wash.*[1]—Continued

Soil and location	Depth in inches	Color [2]		pH [3]	Water stability of aggregates [4]
		Dry	Moist		
Felida clay loam, 5 to 15 percent slopes (SW¼NE¼ sec. 8, T. 1 N., R. 5 E.).	0 to 6	Dark brown (10YR 4/3)	Dark grayish brown (10YR 4/2).	5. 5	Very stable.
	6 to 17	Brown (10YR 4/3)	Dark brown (7.5YR 3/4)	5. 5	Very stable.
	17 to 38	Yellowish brown (10YR 5/4)	Dark brown (10YR 4/3)	4. 5	Very stable to stable.
	38 to 70	Brown (10YR 5/3)	Dark yellowish brown (10YR 4/4).	4. 5	Stable.
	70 to 86	Light yellowish brown (10YR 6/4).	Yellowish brown (10YR 5/4)	4. 5	Stable.
Felida silt loam, 5 to 15 percent slopes (SE¼ sec. 18, T. 1 N., R. 5 E.).	0 to 4	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6. 0	Very stable.
	4 to 9	Grayish brown (10YR 5/2)	Same	5. 6	Very stable.
	9 to 12	Grayish brown (10YR 5/2)	Same	5. 5	Very stable.
	12 to 19	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	5. 7	Very stable.
	19 to 34	Pale brown (10YR 6/3)	Brown (10YR 5/3)	5. 4	Very stable.
	34 to 57	Pale brown (10YR 6/3)	Brown (10YR 4/2)	5. 4	Stable.
	57 to 90	Light yellowish brown (10YR 6/4).	Yellowish brown (10YR 5/4)	4. 5	Stable.
	90 to 110	Light yellowish brown (10YR 6/4).	Yellowish brown (10YR 5/4)	4. 5	Stable to very stable.
Greenwater gravelly sand, 2 to 5 percent slopes (NW¼ NE¼ sec. 28, T. 7 N., R. 5 E.).	0 to 3	Very dark grayish brown (10YR 3/2).		4. 5	
	3 to 5	Brown (10YR 4/3)	Dark brown (10YR 3/3)	5. 1	
	5 to 40	Pale brown (10YR 6/3)	Dark brown (10YR 4/3)	5. 8	
	40 to 65	Light brownish gray (2.5Y 6/2).	Grayish brown (2.5Y 5/2)	6. 0	

Greenwater gravelly sandy loam, 2 to 5 percent slopes (NE¼SE¼ sec. 25, T. 7 N., R. 5 E.).	2½ to 0	Very dark grayish brown (10YR 3/2).		4. 5	
	0 to 4	Gray (10YR 5/1)	Dark gray (10YR 4/1)	4. 7	
	4 to 12	Brown (10YR 5/3)	Dark grayish brown (10YR 4/2).	5. 5	
	12 to 32	Light gray (2.5Y 7/2)	Dark grayish brown (2.5Y 4/2)	6. 3	
	32 to 42	Light olive gray (5Y 6/2)	Olive gray (5Y 4/2)	6. 4	
Greenwater gravelly sand, 15 to 35 percent slopes (sec. 29, T. 7 N., R. 5 E.).	2 to 0	Very dark grayish brown (10YR 3/2).		5. 0	
	0 to 4	Grayish brown (10 YR 5/2)	Very dark grayish brown (10YR 3/2)	5. 5	
	4 to 11	Grayish brown to brown (10YR 5/2.5).	Dark grayish brown (10YR 4/2).	5. 6	
	11 to 70	Pale brown (10YR 6/3)	Dark brown (10YR 4/3)	5. 9	
	70 to 82	Pale brown (10YR 6/3)	Dark brown (10YR 4/3)	6. 1	
Hesson clay loam, 5 to 15 percent slopes (SE¼SW¼ sec. 6, T. 1 N., R. 5 E.).	2 to 0	Dark brown (7.5YR 3/2)		5. 4	Very stable.
	0 to 5	Dark brown (7.5YR 4/2)	Dark brown (7.5YR 3/2)	5. 5	Very stable.
	5 to 11	Dark brown (7.5YR 4/2)	Dark brown (7.5YR 3/2)	5. 5	Very stable.
	11 to 17	Dark brown (7.5YR 4/2)	Dark brown (7.5YR 3/2)	5. 5	Very stable.
	17 to 23	Brown (7.5YR 5/4)	Dark reddish brown (5YR 3/4)	5. 0	Very stable.
	23 to 38	Brown (7.5YR 5/4)	Dark reddish brown (5YR 3/4)	[5] 4. 5	Very stable
	38 to 44	Brown (7.5YR 5/4)	Reddish brown (5YR 4/3)	[5] 4. 5	Very stable.
	44 to 80	Reddish brown (5YR 4/4)	Dark red (2.5YR 3/6)	[5] 4. 5	Stable.
Hillsboro fine sandy loam, 5 to 15 percent slopes (NE¼NE¼ sec. 34, T. 3 N., R. 8 E.).	½ to 0	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	6. 0	
	0 to 2	Same	Very dark brown (10YR 2/2)	5. 9	Very stable.
	2 to 8	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	5. 8	Very stable.
	8 to 66	Brown (10YR 5/3)	Dark brown (10YR 3/3)	6. 1	
	66 to 84	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 4/4).	6. 1	
Hood silt loam, 30 to 40 percent slopes (NW¼ sec. 3, T. 3 N., R. 10 E.).	2 to 0	Dark grayish brown (10YR 4/2).		6. 0	Very stable.
	0 to 7	Dark brown (7.5YR 4/2)	Dark brown (7.5YR 3/2)	6. 2	Very stable.
	7 to 17	Brown (10YR 5/3)	Dark brown (7.5YR 3/2)	6. 1	Very stable.
	17 to 32	Light yellowsh brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	6. 0	Stable.
	32 to 84	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5. 5	Moderately stable.

See footnotes at end of table.

TABLE 7.—*Color, pH, and water stability of the aggregates of some of the important soils of Skamania County, Wash.*[1]—Continued

Soil and location	Depth in inches	Color [2]		pH [3]	Water stability of aggregates [4]
		Dry	Moist		
Olympic clay loam, 2 to 15 percent slopes (SE¼ sec. 34, T. 2 N., R. 5 E.).	1 to 0	Dark grayish brown (10YR 4/2).	Dark grayish brown (10YR 4/2).	6. 1	Very stable.
	0 to 6	Dark reddish brown (5YR 3/4).	Dark reddish brown (5YR 3/3).	6. 1	Very stable.
	6 to 15	Dark reddish brown (5YR 3/4).	Dark reddish brown (5YR 3/3).	6. 0	Very stable.
	15 to 35	Dark reddish brown (5YR 3/4).	Dark reddish brown (5YR 3/3).	5. 5	Very stable.
	35 to 46	Reddish brown (2.5YR 4/4)	Dark reddish brown (2.5YR 3/4).	[5] 5. 0	Very stable.
	46 to 75	Reddish brown (2.5YR 4/4)	Dark reddish brown (2.5YR 3/4).	[5] 5. 0	Very stable.
Olympic clay loam, 15 to 30 percent slopes (SE¼ sec. 26, T. 2 N., R. 5 E.).	1½ to 0	Very dark grayish brown (10YR 3/2).	----------	6. 2	Very stable.
	0 to 4	Dark brown (7.5YR 3/2)	Very dark brown (7.5YR 2/2)	6. 0	Very stable.
	4 to 17	Dark brown (7.5YR 3/2)	Dark reddish brown (5YR 3/3).	5. 8	Very stable.
	17 to 30	Dark brown (7.5YR 4/4)	Dark reddish brown (5YR 3/4).	5. 8	Very stable.
	30 to 57	Dark brown (10YR 4/3)	Dark reddish brown (5YR 3/4).	5. 5	Very stable.
	57 to 70	Brown (10YR 4/4)	Dark reddish brown (5YR 3/4).	5. 5	Very stable.

Olympic stony clay loam, 2 to 15 percent slopes (SE¼ sec. 26, T. 2 N., R. 5 E.).	1½ to 0	Dark grayish brown (10YR 4/2).	Dark grayish brown (10YR 4/2).	6. 0	Very stable.
	0 to 4	Dark brown (7.5YR 3/2)	Dark reddish brown (5YR 2/2).	5. 7	Very stable.
	4 to 9	Dark brown (7.5YR 3/2)	Dark reddish brown (5YR 2/2).	5. 6	Very stable.
	9 to 20	Weak red (2.5YR 4/2)	Dusky red (2.5YR 3/2)	5. 5	Very stable.
	20 to 37	Weak red (10R 5/2)	Weak red (10R 4/2)	[5] 5. 3	Stable.
	37 to 55	Weak red (10R 5/3)	Weak red (10R 4/3)	[5] 4. 5	Very stable.
Olympic stony loam, 30 to 70 percent slopes (SW¼SE¼ sec. 23, T. 2 N., R. 6 E.).	1 to 0	Dark brown (7.5YR 3/2)	Very dark brown (7.5YR 2/2)	6. 1	Very stable.
	0 to 4	Dark brown (7.5YR 4/4)	Dark reddish brown (5YR 3/3).	6. 1	Very stable.
	4 to 17	Dark brown (7.5YR 4/4)	Dark reddish brown (5YR 3/4).	6. 0	Very stable.
	17 to 34	Dark brown (7.5YR 4/4)	Dark reddish brown (5YR 3/4).	5. 5	Very stable.
	34 to 60	Brown (7.5YR 5/4)	Dark reddish brown (5YR 3/4).	[5] 5. 0	Stable.
Riffe fine sandy loam, 0 to 3 percent slopes (NW¼ sec. 17, T. 3 N., R. 8 E.).	1 to 0	Very dark grayish brown (10YR 3/2).	----------	6. 0	
	0 to 3	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6. 1	Very stable.
	3 to 8	Brown (10YR 5/3)	Dark brown (10YR 4/3)	6. 0	Very stable.
	8 to 18	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 4/4).	6. 0	Very stable.
	18 to 30	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 4/4).	5. 6	Very stable.
	30 to 70	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5. 3	Stable.
St. Helens pumicy sandy loam, 30 to 70 percent slopes (NE¼NW¼ sec. 25, T. 7 N., R. 5 E.).	4 to 0	Dark grayish brown (10YR 4/2).	----------	5. 0	
	0 to 5	Gray (10YR 5/1)	Very dark gray (10YR 3/1)	5. 0	
	5 to 7	Gray (10YR 6/1)	Dark grayish brown (10YR 4/2).	5. 5	
	7 to 21	Light gray (10YR 7/2)	Dark brown (10YR 4/3)	6. 0	
	21 to 30	Very pale brown (10YR 7/3)	Brown (10YR 5/3)	6. 0	
	30 to 52	Very pale brown (10YR 7/3)	Brown (10YR 5/3)	6. 4	
	52 to 96	White (10YR 8/2)	Very pale brown (10YR 7/3)	6. 3	

See footnotes at end of table.

TABLE 7.—*Color, pH, and water stability of the aggregates of some of the important soils of Skamania County, Wash.*[1]—Continued

Soil and location	Depth in inches	Color [2]		pH [3]	Water stability of aggregates [4]
		Dry	Moist		
St. Martin clay loam, 15 to 30 percent slopes (sec. 19, T. 3 N., R. 8 E.).	½ to 0	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	6.0	Very stable.
	0 to 4	Same	Very dark brown (10YR 2/2)	6.0	Very stable.
	4 to 16	Dark grayish brown (10YR 3/2).	Very dark grayish brown (10YR 3/2).	5.4	Very stable.
	[6] 16 to 29	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	5.1	Stable to moderately stable.
	[6] 29 to 58	Light brownish gray (10YR 6/2).	Grayish brown (10YR 5/2)	5.1	Slightly stable.
	58 to 72	Light gray (10YR 7/2)	Grayish brown (10YR 5/2)	6.1	Slightly stable.
St. Martin stony clay loam, 15 to 30 percent slopes (NW¼NE¼ sec. 36, T. 3 N., R. 8 E.).	1½ to 0	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	6.1	Very stable.
	0 to 5	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6.1	Very stable.
	5 to 12	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	6.0	Very stable.
	12 to 18	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	5.5	Stable.
	[6] 18 to 34	Light brownish gray (10YR 6/2).	Grayish brown (10YR 5/2)	5.0	Slightly stable.
	34 to 66	Light gray (10YR 7/2)	Grayish brown (10YR 5/2)	5.7	Slightly stable.
	66 to 80	White (10YR 8/2)	Light brownish gray (10YR 6/2).	6.0	Slightly stable.
Semiahmoo muck, 0 to 2 percent slopes (NE¼ sec. 26, T. 3 N., R. 8 E.).	0 to 14	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	6.0	
	14 to 28	Same	Very dark brown (10YR 2/2)	6.0	
	28 to 60	Same	Very dark brown (10YR 2/2)	6.0	

Skamania silt loam, 15 to 30 percent slopes (SW¼ sec. 34, T. 2 N., R. 6 E.).	2 to 0	Dark brown (7.5YR 3/2)	Very dark brown (7.5YR 2/2)	6. 2	Very stable.
	0 to 6	Dark brown (10YR 4/3)	Very dark grayish brown (10YR 3/2).	6. 2	Very stable.
	6 to 12	Brown (10YR 5/3)	Dark brown (7.5YR 3/4)	6. 6	Very stable.
	12 to 27	Yellowish brown (10YR 5/4)	Dark brown (7.5YR 3/4)	6. 0	Stable.
	27 to 36	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5. 5	Stable.
	36 to 80	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5. 5	Stable.
Skamania very fine sandy loam, 30 to 40 percent (SE¼ sec. 36, T. 3 N., R. 7½ E.).	1½ to 0	Dark brown (7.5YR 3/2)		6. 0	
	0 to 8	Brown (10YR 5/3)	Dark brown (10YR 3/3)	6. 0	Very stable.
	8 to 16	Light yellowish brown (10YR 6/4).	Dark brown (10YR 4/3)	6. 1	Stable.
	16 to 39	Light yellowish brown (10YR 6/5).	Brown (10YR 4/3)	5. 5	
	39 to 60	Light yellowish brown (10YR 6/4).	Brown (10YR 4/3)	5. 4	
Stabler shotty loam, 0 to 2 percent slopes (NE¼SW¼ sec. 36 T. 4 N., R. 7½ E.).	1 to 0	Very dark grayish brown (10YR 3/2).		6. 0	Very stable.
	0 to 4	Brown (10YR 5/3)	Dark brown (7.5YR 3/2)	5. 8	Very stable.
	4 to 14	Brown (10YR 5/3)	Dark brown (7.5YR 3/2)	5. 8	Very stable.
	14 to 30	Light yellowish brown (10YR 6/4).	Dark brown (7.5YR 4/4)	5. 5	Very stable.
	30 to 40	Light yellowish brown (10YR 6/4).	Dark brown (7.5YR 4/4)	5. 5	Very stable.
	40 to 52	Light gray (10YR 7/2)	Light brownish gray (10YR 6/2).	[5] 5. 3	Very stable.
	52 to 70	Light gray (10YR 7/2)	Light brownish gray (10YR 6/2).	[5] 5. 3	Very stable.
Stevenson clay loam, 2 to 15 percent slopes (NE¼NE¼ sec. 36, T. 3 N., R. 7½ E.).	1½ to 0	Dark brown (7.5YR 3/2)		6. 0	
	0 to 9	Dark grayish brown (10YR 4/2).	Very dark brown (10YR 2/2)	6. 0	Very stable.
	9 to 37	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	5. 5	Stable to moderately stable.
	37 to 50	Pale brown (10YR 6/3)	Brown (10YR 4/3)	[5] 5. 0	Slightly stable.
	50 to 70	Pale brown (10YR 6/3)	Brown (10YR 4/3)	[5] 5. 0	Slightly stable.

See footnotes at end of table.

TABLE 7.—*Color, pH, and water stability of the aggregates of some of the important soils of Skamania County, Wash.*[1]—Continued

Soil and location	Depth in inches	Color [2]		pH [3]	Water stability of aggregates [4]
		Dry	Moist		
Stevenson stony loam, 30 to 70 percent slopes: NW¼SW¼ sec. 14, T. 2 N., R. 6 E.	½ to 0	Very dark grayish brown (10YR 3/2).		6. 1	
	0 to 5	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6. 1	
	5 to 11	Grayish brown (10YR 5/2)	Same	5. 4	
	11 to 36	Light brownish gray (10YR 6/2).	Dark grayish brown (10YR 4/2).	[5] 5. 0	
	36 to 47	Light gray (10YR 7/2)	Grayish brown (10YR 5/2)	[5] 5. 1	
	47 to 62	Light gray (10YR 7/2)	Grayish brown (10YR 5/2)	[5] 5. 1	
Sec. 26, T. 2 N., R. 6 E.	½ to 0	Very dark grayish brown (10YR 3/2).		6. 4	
	0 to 5	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6. 1	Very stable.
	5 to 17	Dark grayish brown (10YR 4/2).	Same	6. 0	Very stable.
	17 to 24	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	5. 7	Stable.
	24 to 50	Brown (10YR 5/3)	Dark brown (10YR 4/3)	[5] 5. 1	Slightly stable.
Toutle gravelly sand, 0 to 3 percent slopes (NE¼NE¼ sec. 27, T. 7 N., R. 5 E.).	0 to 3	Dark brown (7.5YR 3/2)		6. 1	
	3 to 6	Gray (10YR 5/1)	Very dark gray (10YR 3/1)	6. 1	
	6 to 40	Brown (10YR 5/3)	Dark brown (10YR 4/3)	6. 1	
Toutle sand, 0 to 3 percent slopes (SE½NE¼ sec. 27, T. 7 N., R. 5 E.).	1½ to 0	Dark brown (7.5YR 3/2)		4. 5	
	0 to 3	Gray (10YR 5/1)	Very dark gray (10YR 3/1)	5. 0	
	3 to 40	Gray to light gray (5Y 6/1 and 10YR 7/1).	Dark gray (5Y 4/1)	6. 0	
	40 to 54	Grayish brown (10YR 5/2)	Dark grayish brown (10YR 4/2).	6. 1	

Underwood stony loam, 30 to 70 percent slopes:	1½ to 0	Dark brown (7.5YR 3/2)		6.5	
	0 to 5	Brown (7.5YR 4/4)	Dark reddish brown (5YR 3/3).	6.5	Very stable.
NW¼ sec. 15, T. 3 N., R. 10 E.	5 to 18	Brown (7.5YR 5/4)	Dark reddish brown (5YR 3/4).	6.3	Very stable.
	18 to 60	Brown (7.5YR 5/4)	Reddish brown (5YR 4/4)	5.7	Very stable.
	60 to 70	Brown (7.5YR 5/4)	Dark brown (7.5YR 4/4)	6.2	Stable.
Sec. 24, T. 3 N., R. 9 E.	2 to 0	Dark brown (7.5YR 3/2)		6.1	
	0 to 11	Reddish gray (5YR 5/2)	Dark reddish brown (5YR 3/4).	6.1	Very stable.
	11 to 40	Reddish brown (5YR 5/4)	Reddish brown (5YR 4/4)	6.0	Stable.
	40 to 60	Reddish brown (5YR 5/4)	Reddish brown (5YR 4/4)	[5] 5.5	Stable.
	60 to 80	Reddish brown (5YR 5/4)	Reddish brown (5YR 4/4)	[5] 5.3	Stable.
NE¼ sec. 30, T. 3 N., R. 10 E.	2 to 0	Dark brown (10YR 4/3)	Dark brown (7.5YR 3/2)	6.0	Very stable.
	0 to 8	Brown (7.5YR 5/4)	Dark brown (7.5YR 3/4)	6.2	Very stable.
	8 to 11	Brown (7.5YR 5/4)	Dark brown (7.5YR 3/4)	6.2	Very stable.
	11 to 24	Brown (7.5YR 5/4)	Dark brown (7.5YR 3/4)	6.1	Stable.
	24 to 35	Brown (7.5YR 5/4)	Dark brown (7.5YR 4/4)	6.1	Stable.
Underwood stony loam, 15 to 30 percent slopes (SE¼ sec. 15, T. 3 N., R. 10 E.).	1 to 0	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6.2	
	0 to 6	Brown (10YR 5/3)	Dark grayish brown (10YR 4/2).	6.2	Very stable.
	6 to 32	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 4/4).	5.0	Stable.
	32 to 90	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5.1	Stable to moderately stable.
Underwood stony loam, 2 to 15 percent slopes (SW¼ sec. 15, T. 3 N., R. 10 E.).	½ to 0	Very dark grayish brown (10YR 3/2).		6.4	
	0 to 10	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6.4	Very stable.
	10 to 17	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 4/4).	6.3	Very stable.
	17 to 20	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 4/4).	6.0	Stable to very stable.
	20 to 38	Light yellowish brown (10YR 6/4).	Yellowish brown (10YR 5/6)	5.5	Stable.
	38 to 60	Light yellowish brown (10YR 6/4).	Yellowish brown (10YR 5/6)	5.5	

See footnotes at end of table.

TABLE 7.—*Color, pH, and water stability of the aggregates of some of the important soils of Skamania County, Wash.*[1]—Continued

Soil and location	Depth in inches	Color[2]		pH[3]	Water stability of aggregates[4]
		Dry	Moist		
Wapato clay loam, 0 to 3 percent slopes (SW¼SE¼ sec. 27, T. 3 N., R. 8 E.).	0 to 7	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	5. 9	Very stable.
	7 to 28	Light brownish gray (10YR 6/2).	Dark grayish brown (10YR 4/2).	6. 0	Stable.
	28 to 60	Light brownish gray (10YR 6/2).	Dark grayish brown (10YR 4/2).	6. 1	Stable to moderately stable.
Washougal loam, 0 to 3 percent slopes (SW¼NW¼ sec. 20, T. 2 N., R. 7 E.).	0 to 2½	Very dark grayish brown (10YR 3/2).	Very dark brown (10YR 2/2)	6. 2	Very stable.
	2½ to 19	Dark brown (7.5YR 4/2)	Very dark grayish brown (10YR 3/2).	6. 0	Stable.
	19 to 29	Brown (10YR 5/3)	Dark brown (10YR 3/3)	6. 0	Slightly stable.
	29 to 46	Brown (10YR 5/3)	Dark yellowish brown (10YR 4/4).	6. 0	
	46 to 60	Yellowish brown (10YR 5/4)	Dark yellowish brown (10YR 3/4).	6. 1	
Washougal loam, seeped, 0 to 3 percent slopes (SE¼ sec. 32, T. 2 N., R. 5 E.).	1 to 0	Very dark grayish brown (10YR 3/2).		5. 5	
	0 to 15	Same	Very dark brown (10YR 2/2)	5 3	Very stable.
	15 to 24	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	5. 3	Very stable.
	24 to 40	Grayish brown to brown (10YR 5/2–5/3).	Dark brown (10YR 4/3)	5. 4	Very stable.

Wind River gravelly loam, 2 to 5 percent slopes (sec. 21, T 3 N., R. 8 E.).	2 to 0	Very dark grayish brown (10YR 3/2).	----------	6. 0
	0 to 14	Dark grayish brown (10YR 4/2).	Very dark grayish brown (10YR 3/2).	6. 0
	14 to 26	Dark grayish brown (10YR 4/2).	Same----------	6. 0
	26 to 36	Brown (10YR 4/3)----------	Dark brown (10YR 3/3)------	6. 0
	36 to 47	Dark brown (10YR 5/3)------	Dark brown (10YR 4/3)------	5. 5
	47 to 64	Brown (10YR 5/3)----------	Dark brown (10YR 4/3)------	5. 7
Wind River gravelly loam, 30 to 70 percent slopes (NE¼ sec. 28, T. 3 N., R. 8 E.).	2½ to 0	Dark yellowish brown (10YR 3/4).	----------	6. 1
	0 to 9	Dark brown (10YR 4/3)------	Dark brown (10YR 3/3)------	6. 0
	9 to 24	Brown (10YR 5/3)----------	Dark yellowish brown (10YR 4/4).	5. 7
	24 to 80	Light yellowish brown (10YR 6/4).	Dark yellowish brown (10YR 4/4).	5. 5

[1] Determinations by Ray. C. Roberts, Soil Correlator.

[2] Symbols express Munsell notations.

[3] Determined with Hellige Triplex indicator on air-dry samples several years after they were collected from the field.

[4] Determined by submerging air-dry aggregates in cold water. If aggregate stayed hard and firm for a period exceeding 30 minutes, material was considered very stable; if it disintegrated within about 2 minutes it was considered stable; if it disintegrated within half a minute it was considered moderately stable; if it disintegrated within half a second it was considered slightly stable; if it disintegrated immediately it was considered nonstable. Determinations were not made for very sandy or very gravelly samples, and these are indicated by blanks.

[5] Indicator changes to almost white or light gray.

[6] This layer is slightly mottled with 10YR 5/6 specks.

It can be readily seen from table 7 that most soils have a pH of 6 in the surface horizon and gradually become more acid with depth. This is especially true of the Chemawa, Olympic, Riffe, Skamania, Stabler, Stevenson, and Wind River soils. This is a characteristic of most lateritic soils, whereas most podzolic soils are more acid in the surface soils than at depths below 40 or 50 inches.

The Hellige triplex indicator turned almost white when applied to the samples of the lower depths of most of the soils listed in the preceding paragraph. This is another indication of the lateritic nature of the soils.

The Cougar, Greenwater, and St. Helens soils have very strongly acid surface horizons, but the acidity decreases with depth. These soils are classified as Podzols. It is interesting to note that the A_0 horizon in these soils is very acid, but in the other soils this horizon is about pH 6.

Young soils, as the Bonneville, Burlington, Chehalis, Columbia, Newberg, Toutle, Washougal, and Wapato, have less acid profiles than the older soils.

As a general rule the more gravelly the soil, the less acid the profile. Underwood and Olympic soils are from similar parent materials, but Olympic soils are more acid, apparently because they occur in areas of high precipitation.

Most of the soils, when dry, have a dark grayish-brown or dark-brown A_1 horizon. This is fairly dark color for soils densely covered with forests. The Bear Prairie soils, which are classified as "Ando" soils mainly because they are not forested, are not any darker than some of the soils with dense forest cover. The dark color, however, extends deeper in the profile of the Bear Prairie soils than in the forested soils.

The soils derived from the most basic materials have the most intense red color. The moist samples become darker or redder than the air-dry samples.

In the well-drained, medium- to fine-textured soils, even the soil aggregates from a depth of 4 feet or lower are very stable in water. This is a characteristic of lateritic soils. The aggregates are distinctly rounded, and those from the upper layers especially are quite hard in water.

The St. Martin and Stevenson soils have aggregates in their lower horizons that are less water stable. These soils may have a much higher percentage of montmorillonitic clays than the other soils of the area.

In general, the well-drained soils in areas of least precipitation do not have aggregates so water stable in the lower part of the profile as the well-drained soils in areas of highest precipitation. Aggregates in the lower part of the profile of young soils such as the Bonneville and Chehalis and well-drained Washougal soils are not so stable in water as in the older more mature soils.

The soils of Skamania County have not been sufficiently studied nor have some of the soil groups been adequately defined to indicate definitely that the soils are of one great soil group or another. It is possible that, in time, some of the soils now listed under one group may be changed to another or to a new soil group. Several of the

soil group names used in this report are only tentative and are subject to change; therefore, they are in quotation marks.

Table 8 shows the mechanical analyses and organic-matter content for samples of several soils of Skamania County. It can be seen from this table that, except for the Hesson and Underwood soils, all the soils listed have a low clay content and a rather high organic-matter content. The fine gravel consists mostly of shot.

CLASSIFICATION OF SOILS

The soil series of Skamania County are classified according to great soil group as follows:

"Brown Lateritic":
- Hesson
- Olympic
- Nesika
- Riffe

Brown Podzolic-"Brown Lateritic" intergrade:
- Chemawa
- Hillsboro
- Skamania
- Stabler
- Wind River

Podzol:
- Cougar
- Greenwater
- St. Helens

"Ando":
- Bear Prairie

Gray-Brown Podzolic:
- Felida
- Hood

"Western Brown Forest":
- Underwood

"Western Brown Forest-Grumusols" intergrade:
- Stevenson
- St. Martin

Humic Gley:
- Martha
- Wapato

Organic soils:
- Semiahmoo

Regosol:
- Burlington

Aluvial:
- Bonneville
- Chehalis
- Columbia
- Newberg
- Toutle
- Washougal

"BROWN LATERITIC"

"Brown Lateritic" is a tentative name given to many of the soils in southwestern Washington that have developed under a forest cover and a subhumid climate and that have the following general characteristics (*4*): (1) a thin dark-brown organic layer; (2) a dark-brown or brown to faintly reddish-brown medium acid friable granular and fairly thick A_1 horizon composed predominantly of fine-textured water-stable aggregates and grading to brown or yellowish-brown granular and permeable B horizons without appreciable compaction or accumulation of clay or sesquioxides over the C horizons; (3) numerous spheroidal shot pellets ranging in diameter from ⅛ to ¼ inch in the A_1 and upper B horizons; (4) highly and deeply weathered parent materials from basic igneous rocks or of mixed origin from various rocks; (5) acid and becoming slightly more acid with depth. These characteristics are most strongly developed in soils of the uplands and less strongly developed in soils of the younger terraces.

The following soil series are classified as Brown Lateritic: Hesson, Olympic, Nesika, and Riffe.

TABLE 8.—*Mechanical analyses and organic-matter content of samples of several soils of Skamania County, Wash.*[1]

Soil and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	Organic-matter content by H_2O_2
Hillsboro fine sandy loam, 5 to 15 percent slopes:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
552445	½– 2	0.1	2.0	10.0	20.2	18.0	40.3	9.4	9.5
552446	2– 8	.1	1.8	16.3	39.9	12.2	24.4	5.3	2.5
552447	8– 66	0	.8	18.3	49.4	13.1	15.9	2.5	.6
552448	66– 84	0	.4	17.9	58.2	13.3	8.3	1.9	.1
Chemawa shotty loam, 15 to 30 percent slopes:									
552465	1½– 6	3.8	9.9	13.6	13.6	11.0	40.0	8.1	5.0
552466	6– 17	4.5	8.8	9.5	12.5	9.9	45.5	9.3	1.0
552467	17– 22	2.9	9.3	10.0	11.7	10.1	48.6	7.4	1.0
552468	22– 40	1.9	8.7	9.5	12.2	10.2	51.1	6.4	.2
552468½	40– 65	2.1	8.8	9.9	13.7	14.7	45.6	5.2	0
Underwood stony loam, 30 to 70 percent slopes:									
552481	2– 11	6.1	9.2	8.0	8.9	6.9	42.6	18.3	4.0
552482	11– 40	1.1	5.5	5.2	7.9	7.5	47.9	24.9	0
552483	40– 60	1.4	4.8	3.7	6.5	6.9	47.0	29.7	0
552484	60– 80	.9	3.1	2.8	5.5	7.2	48.9	31.6	0
Hesson clay loam, 5 to 15 percent slopes:									
5524118	2– 5	.3	1.2	1.8	4.1	8.3	53.8	30.5	12.3
5524119	5– 11	.2	1.2	1.8	3.7	9.1	53.3	30.7	7.7
5524120	11– 17	.3	1.2	1.7	4.0	8.7	56.9	27.2	5.4
5524121	17– 23	.2	1.3	1.8	4.4	12.3	66.4	13.6	.5
5524122	23– 38	.2	1.0	1.5	3.8	10.7	67.7	15.1	.3
5524123	38– 44	.1	1.1	1.6	3.6	9.4	64.8	19.4	.2
5524124	44– 80	.4	1.4	1.8	3.1	4.0	39.1	50.2	.2

Skamania silt loam, 2 to 15 percent slopes:									
5524212	0– 9	0	.6	1.0	5.0	25.6	60.8	7.0	8.9
5524213	9– 12	0	.4	.8	4.0	29.8	60.0	5.0	4.8
5524214	12– 23	0	.1	.6	4.8	34.9	56.0	3.6	2.5
5524215	23– 46	0	.1	.3	3.4	37.9	55.7	2.6	1.2
5524216	46– 75	0	.1	.1	3.5	38.7	55.4	2.2	.1
5524217	75–100	.3	1.6	1.8	9.1	31.3	47.3	8.6	.3

[1] Samples analyzed by Soil Survey laboratory, U. S. Department of Agriculture, Beltsville, Md.

Olympic stony clay loam, 15 to 30 percent slopes, has the following characteristics:

A_0 1½ to 0 inches, dark reddish-brown organic mat of leaves, twigs, fir needles, cones, and moss; fairly well decomposed in the lower part; acid.

A_1 0 to 6 inches, dark-brown (7.5YR 4/4) stony clay loam; dark reddish brown (5YR 3/3) when moist; friable; contains a large number of shot, angular gravel, and stones; good distribution of roots; medium granular and very stable; strongly acid.

A_3 6 to 16 inches, brown (7.5YR 5/4) water-stable clay loam; many rocks and angular pieces of gravel; reddish brown (5YR 4/3) when moist; low organic content: trace of shot in lower part; firm in place but easily broken up into friable granular or irregular fragments; moderately plastic when wet; strongly acid.

B_2 16 to 34 inches, reddish-yellow (7.5YR 6/6) stony clay loam or silty clay; strong brown (7.5YR 5/6) when moist; firm in place but permeable and breaks up into subangular blocky aggregates that may be easily crushed into a granular mass that is plastic and sticky when wet; aggregates highly coated with colloidal material and moderately water-stable; about 30 percent of layer consists of angular stones and gravel; strongly acid.

B_3 34 to 60 inches, reddish-yellow (7.5YR 6/6) or strong-brown (7.5YR 5/6) heavy clay loam or clay; occurs as interstitial material between the rock and gravel that make up more than 65 percent of the material; many splotches of olive brown, grayish brown, and purple from partly decomposed rock in the lower part; red or dark red in places; firm in place but permeable to water and plant roots; strongly acid.

C 60 inches +, partly decomposed and disintegrated rock having reddish-brown gritty clay as interstitial material; bedrock at 2 to 10 feet.

The other members of the Brown Lateritic soil group have similar general characteristics, but most of them are not so highly developed as the Olympic soils.

BROWN PODZOLIC-"BROWN LATERITIC" INTERGRADE

The soils of the Brown Podzolic-"Brown Lateritic" intergrade are the Chemawa, Hillsboro, Skamania, Stabler, and Wind River. They have some characteristics of the Brown Podzolic soils of northwestern Washington but they have an A_1 horizon 4 to 6 inches thick and do not have an A_2. They have very little clay in the B or C horizon and generally become more acid with depth. They have water-stable aggregates to low depths.

Chemawa shotty loam, 5 to 15 percent slopes, has the following characteristics:

A_0 1 to 0 inches, dark grayish-brown to very dark grayish-brown or black (10YR 4/2 to 10YR 3/2; or 10YR 2/1, moist) decomposed leaf mat of Douglas-fir needles covered loosely with twigs, needles, and pieces of bark, all partly decomposed; few if any large roots at junction of this layer and the A_1; contact between two horizons is abrupt and wavy; leaf mat has pH of 5.4.

A_1 0 to 4 inches, brown to dark-brown (10YR 4/3; 10YR 3/2, moist) shotty loam; probably 40 percent of layer consists of hard shot $\frac{1}{10}$ to ¼ inch in diameter; most of shot, when dry, are brown on outside and reddish, with a dark-brown center, on the inside; shot are of various shapes—round, angular, and a few nearly flat; excluding shot, horizon has strong coarse and medium structure and is non-sticky but slightly plastic; material soft when dry and very friable when moist; this layer, like next two below, very easy to dig with a spade when wet or dry; layer has pH of 6.4 and gradually grades to layer below.

B_{21} 4 to 11 inches, brown to dark-brown (10YR 5/3 to 7.5YR 3/4, moist) strong medium subangular blocky and strong very coarse granular shotty loam; high shot content but less than in A_1 horizon; size, shape, and hardness of shot about the same as in A_1; this horizon soft, friable, and slightly plastic; has many large, healthy looking roots and a few small earthworms; pH 5.7.

B_{22} 11 to 21 inches, yellowish-brown to dark-brown (10YR 5/4 to 7.5YR 3/4, moist) loam containing considerable shot that are larger than those in horizon above but softer; most of shot can be crushed between the fingers; horizon has moderate medium subangular blocky structure; layer soft when dry but very friable when moist and slightly plastic when wet; roots, air, and water penetrate freely; abruptly joins layer below and has a very wavy boundary; tongues of this horizon extend 3 to 5 inches into horizon below; pH 5.4.

B_{31} 21 to 35 inches, light yellowish-brown to dark-brown (10YR 6/4 to 7.5YR 4/4, moist) weak medium subangular blocky loam; firm when moist and slightly plastic when wet; horizon contains considerable amount of small fine roots but few or no large roots; gradually grades into layer below; pH 6.2.

B_{32} 35 to 46 inches, similar to layer above in color, pH, consistence, and texture but has larger, weaker, subangular blocky structure; rather abrupt and significant transition to horizon below.

C_{11} 46 to 57 inches, same as layer above in color and pH but has very firm consistence when moist and is moderately plastic when wet; feels like it has less silt and more fine sand than horizon above; has moderate coarse prismatic structure and contains a few manganese specks and some charcoal; most pronounced difference from layers above is high content of glasslike specks that give horizon a raw appearance and a harsh feel when rubbed between the fingers; after considerable rubbing, most of particles feel like they are the size of silt; a few inconspicuous clay flows can be seen around the forms of the few shot; some fine roots follow along the structure forms of the prisms.

C_{12} 57 to 72 inches, similar to layer above in color, pH, and texture but has very firm weak coarse prismatic structure and friable to firm massive structure; slightly less plastic than the horizon above.

C_{13} 72 to 80 inches, pale-brown to dark yellowish-brown, and dark-brown (10YR 6/3, 10YR 4/4, and 7.5YR 4/4, moist) loam; very weak coarse subangular blocky structure; layer has a mixture of friable and firm consistence when moist; pH 5.4.

This soil is light in weight throughout, and especially light in the layers above 45 inches. It has very stable aggregates to a depth of 80 inches or more. The aggregates stay firm for a period exceeding 30 minutes when dropped into water. The soil appears to be derived from ash and pumice. In most places rock occurs at depths of 10 to 30 feet.

PODZOL

The Podzols in Skamania County are those of the Cougar, Greenwater, and St. Helens series. They have developed under a high rainfall and slightly cooler climate in the northern part of the county. These soils have a 2- or 3-inch very strongly acid organic mat of partly decayed leaves and a 1½-inch gray leached A_2 horizon that does not absorb water readily. This layer is underlain by a brown or pale-brown B horizon that is slightly finer textured than the surface soil. The soils occur in a region where the annual rainfall is generally more than 100 inches, but the summer months are usually relatively dry. Some snow falls during winter, and the ground at the higher elevations freezes. These soils do not have a distinct orterde or ortstein, but they have a distinct A_2 and other profile characteristics typical of Podzols in other counties in western Washington (*1*, *4*).

The St. Helens soils have developed from pumice materials. This is a profile representative of the St. Helens pumicy sandy loams:

A_{00} 3 to 1½ inches, brown loose organic mat of fir needles, leaves, bark, twigs, and moss.

A_0 1½ to 0 inches, dark-brown partly decomposed organic material; some sand in lower part.

A_2 0 to 1½ inches, gray (10YR 5/1) loose pumicy loamy sand; strongly acid and slightly darker when moist.

B_1 1½ to 15 inches, very pale-brown (10YR 7/3) friable pumicy sandy loam; yellowish-brown (10YR 5/4) when moist; pumice fragments up to ¼ inch in diameter; strongly acid.

B_2 15 to 30 inches, pink (5YR 7/4) sandy loam containing some gray pumice fragments and occasional streaks of reddish-brown weakly cemented ortstein that in places approaches strongly cemented consistence; yellowish brown (10YR 5/4) when moist; not so acid as horizons above.

C_1 30 to 52 inches, very pale-brown (10YR 7/3) pumicy sandy loam stained with gray and reddish brown and containing much pumice sand; breaks into fragments 3 or 4 inches across that pulverize easily into single-grained structure; brown (10YR 5/3) when moist; not so acid as horizons above.

C_2 52 inches+, white (10YR 8/2) pumicy sandy loam streaked with gray and reddish brown; variegations prominent only when moist; not so compact as horizon above; many feet deep; underlain by weathered basic igneous material or bedrock.

The Cougar and Greenwater soils were derived from coarse-textured stream-laid and glacial outwash materials composed primarily of basic igneous material that contained variable quantities of pumice. These soils are not so highly developed as the St. Helens, and the gray leached A_2 is usually incipient or imperfectly developed.

"ANDO"

"Ando" soils occupy only a small acreage in the county and consist of only one soil series—Bear Prairie. This soil occurs in small treeless areas in a climate where the vegetation normally consists of a luxuriant growth of coniferous forest. It has developed from material similar to that for the surrounding forested land. The prairie areas have a dense growth of bracken, some grass, and occasional clumps of Douglas-fir. These areas may never have been forested, although it is more probable that they once were. Frequent fires probably destroyed the trees, and then ferns and grasses became well established. Trees got a start only recently, when the ferns and grass were destroyed by cultivation or overgrazing.

The Bear Prairie soils, developed from materials similar to those of the Olympic soils, are characterized by a deep, dark, granular, friable, medium acid surface soil over a moderately firm but friable strongly acid subsoil.

GRAY-BROWN PODZOLIC

The Felida and Hood soils have many characteristics in common with the Gray-Brown Podzolic soils, but when they are studied in more detail they may be given another great soil group name. They are very similar to the Williamette soils of Oregon.

"WESTERN BROWN FOREST"

Classified in the "Western Brown Forest" group are the Underwood soils. These soils have an A_1 horizon 4 to 6 inches thick and a structural and textural B horizon. They are less acid with depth.

"WESTERN BROWN FOREST-GRUMUSOLS" INTERGRADE

The Stevenson and St. Martin soils have been placed in the "Western Brown Forest–Grumusols" intergrade. Like the Underwood soils, they have an A_1 horizon 4 to 8 inches thick and a structural and textural B horizon. They have, however, some characteristics of the "Grumusols" in that they crack when dry and have a thin surface mulch.

HUMIC GLEY

The Humic Gley soils of this county—those of the Martha and Wapato series—lack a pronounced gray gley layer and have instead a mottled gray, reddish-brown, and yellowish-brown subsoil and substratum.

The Martha soil occurs in low basins or depressions on river terraces. It is a hydromorphic associate of the well-drained Stabler series and has developed from the same medium-textured, pumicy, mixed, stream-laid materials.

The Wapato is a hydromorphic associate of the Chehalis soil. It occurs in poorly drained depressions. It has a grayish-brown surface soil and a finer textured, mottled, gray subsoil.

ORGANIC SOILS

The organic soils have a mucky or peaty surface soil underlain by peat. They have developed under a swamp or marsh type of vegetation, mostly in a humid or subhumid climate. Semiahmoo muck and its shallow phase are the Organic soils mapped in Skamania County. They are of very small extent and occur in small scattered depressions. These soils are derived from sedge accumulations that are well decomposed on the surface. They are underlain by peaty material dominated by sedge peat.

REGOSOL

Regosols are soils with little or no horizon differentiation, deep over bedrock, and generally nonstony. This group consists of materials such as loess, marine and lacustrine sediments, and sands. Only the Burlington soils can be classified as Regosol in this county. They are deep soils derived from sand blown from the Columbia River Valley.

ALLUVIAL

The soil series of the Alluvial great soils group are the Bonneville, Chehalis, Columbia, Newberg, Toutle, and Washougal. The Chehalis and Newberg soils are derived from mixed basic igneous, shale, and sandstone materials. The Chehalis soil has dark-brown to brown granular and friable surface soil and a slightly lighter colored friable and permeable subsoil. The Newberg soil has developed from more recently deposited materials and occupies positions adjacent to stream channels. It is distinguished from Chehalis in having a lighter colored profile—coarser textured surface soil and sandy subsoil.

Soils of the Toutle series were derived from mixed materials, including glacial rock flour and pumice. They have many characteristics of Podzols and are coarse textured and somewhat excessively drained. The grayish-brown to olive-gray surface soil is loose and

shallow over an olive-gray sandy subsoil and stratified olive gray, pepper-and-salt sand and gravel. The Columbia soils differ from the Toutle soils in having developed from more heterogeneous materials that have been carried great distances. They are also less leached.

The Bonneville and Washougal soils are very dark colored—as dark as Prairie soils. They were derived from mixed gravelly material and are gravelly throughout. The Bonneville soil is shallower and more gravelly than the Washougal soils.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of examining, classifying, and mapping soils in the field. The soil scientist walks over the area at intervals not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each such boring or hole shows the soil to consist of several distinctly different layers, called horizons, which collectively are known as the soil profile. Each of these layers is studied carefully for the things about it that affect plant growth.

The color of each layer is noted. There is usually a relationship between the darkness of the color of the upper layer of soil and its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration.

Texture—the content of sand, silt, and clay in each layer—is determined by the feel of the soil when rubbed between the fingers and is checked by mechanical analyses in the laboratory. Texture determines to a considerable extent the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizers will be held by the soil in forms available to plants or will be leached out, and the difficulty or ease of cultivating the soil.

Soil structure, or granulation, and the number of pores or open spaces between soil particles determine the permeability or perviousness of the soil, and consequently the ease with which plant roots penetrate the soil and water enters it.

Consistence, or the tendency of the soil to crumble or to stick together, determines the degree of difficulty that will be encountered in keeping the soil open and porous under cultivation. Consistence covers such soil characteristics as hardness, friability, plasticity, stickiness, compactness, toughness, and cementation.

Surface soil ordinarily refers to the surface layer, which is usually 5 to 10 inches thick. The layer just below the surface soil is the subsoil; the layer beneath the subsoil, the substratum.

The kind of rocks and the parent soil material that develops from these rocks affect the quantity and kind of plant nutrients found in the soil. Simple chemical tests are made to show the degree of acidity of the soil, and the depth to bedrock or to compact layers is determined. The quantity of gravel or rocks that may interfere with cultivation, the steepness and kind of slope, the quantity of soil lost by erosion, and other external features are observed.

On the basis of all the characteristics here listed, soil areas much alike in the kind, thickness, and arrangement of layers are mapped as one soil type. Some soil types are separated into two or more phases.

For example, if a soil type has slopes ranging from 2 to 40 percent, the type may be mapped in three phases, a rolling phase (2 to 15 percent slopes), a hilly phase (15 to 30 percent slopes), and a steep phase (30 to 40 percent slopes). A soil that has been eroded in places may be mapped in two or more phases—an uneroded phase, an eroded phase, and perhaps a severely eroded phase. No eroded phases, however, were mapped in Skamania County. A soil type is broken into phases primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, the frequency of outcropping bedrock, erosion, or artificial drainage, for example, are characteristics that might cause a soil type to be divided into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture of the surface layer may differ. As long as the other characteristics of the soil layers are similar, soil types are considered to belong in the same soil series. A soil series therefore consists of all soil types, whether the number be only one or several, that are, except for texture of the surface layer, about the same in kind, thickness, and arrangement of layers.

The name of a place near where a soil series was first found is chosen as the name of the series. Thus, Skamania is the name of a series of medium to strongly acid, medium-textured, well-drained brown soils derived from a mixture of alluvial, colluvial, and loesslike materials. They occupy stream terrace or benchlike positions and were first found in Skamania County in areas above the Columbia River. Two types of the Skamania series are found—Skamania silt loam and Skamania very fine sandy loam. Each of these soil types has a different surface soil texture, as their names indicate. Skamania silt loam is divided into three phases: Areas of the soil having 2 to 15 percent slopes; those having 15 to 30 percent slopes; and those having 30 to 40 percent slopes.

Very sandy or gravelly recent deposits of streams or stony or highly dissected slopes that have little or no true soil are not designated by series names but are given descriptive names, such as Riverwash, Rock outcrop, Rough broken land, Lava flows, Made land, and Rough mountainous land.

The soil type or, where the soil type is subdivided, the soil phase, is the mapping unit in soil surveys. It is the unit or the kind of soil that is most nearly uniform and has the narrowest range of characteristics. For this reason soil management can be more definitely specified for it than for broader groups of soils that contain more variation. One can say, for example, that soils of the Felida series require lime and phosphate for successful production of alfalfa.

For the mapping units, however, more specific statements can be made. Felida silt loam, 5 to 15 percent slopes, is gently rolling and one of the best soils in the area for general farming. In contrast, Felida silt loam, 15 to 30 percent slopes, is more strongly sloping, is more susceptible to erosion, has a smaller area in cultivation, and is used mainly for hay and pasture. Felida silt loam, 30 to 40 percent slopes, is too steep for cropping.

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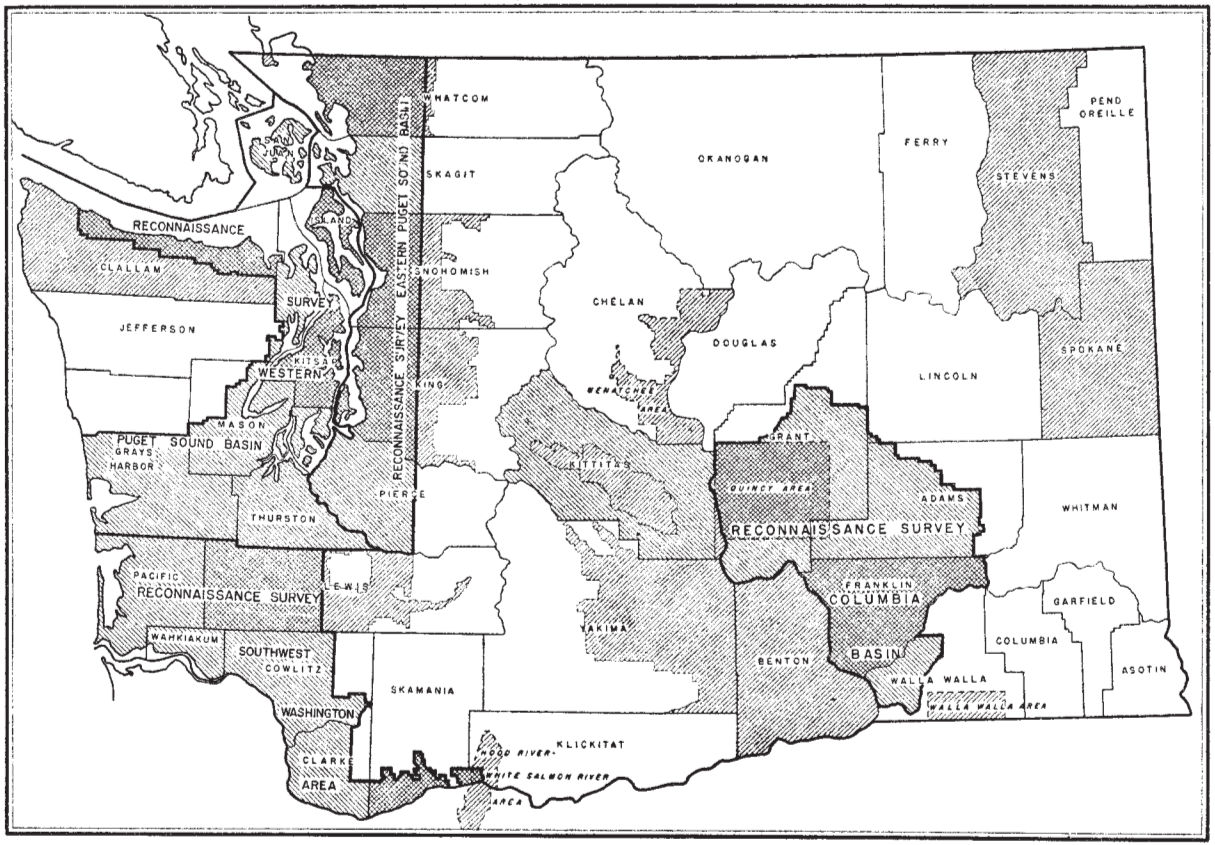

Areas surveyed in Washington: Reconnaissance surveys shown by northwest–southeast hatching; detailed surveys, by northeast–southwest hatching; areas surveyed both ways, by crosshatching.

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