From:	Rebecca Messinger
To:	Gary Medvigy; Glen Yung; Michelle Belkot; Kathleen Otto; Sue Marshall
Cc:	Oliver Orjiako; Jose Alvarez; Cnty 2025 Comp Plan
Subject:	FW: Comments: Clark County Council Hearing on DEIS Alternatives La Center UGA
Date:	Thursday, December 5, 2024 4:23:45 PM
Attachments:	Soil Map La Center Group 1 La Center West of I-5 NW 309th St..pdf La Center Lands.pdf FOCC SSR Letter La Center UGA.pdf Soil Map La Center East of I-5 on NW 31st Ave SSR - Sharon Woosley Request to Rezone AG Property With an Industrial Overlay and Move into the UGB or City of La Center parcel 209749000.pdf 1972-Soil-Survey-of-Clark-County.pdf image001.png image002.png image003.png image004.png

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Please see the attached comments. Thank you.

Rebecca Messinger
Clerk to the Council
COUNTY MANAGER'S OFFICE

564-397-4305

From: Mo McKenna <momoflowerfarm@gmail.com>
Sent: Thursday, December 5, 2024 3:12 PM
To: Rebecca Messinger <Rebecca.Messinger@clark.wa.gov>
Cc: Mo McKenna <momoflowerfarm@gmail.com>
Subject: Comments: Clark County Council Hearing on DEIS Alternatives La Center UGA

Hello Rebecca,

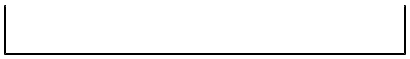
Please add the attached letter and supporting materials below to the public record regarding the Clark County Council Hearing on DEIS Alternatives for tomorrow's 12/6/24 Council Meeting. These comments are specific to the La Center UGA.

Thank you,

Mo McKenna

--
Mo McKenna

Flower Farmer & Florist, MoMo Flower Farm
m: 503-593-7364



Friends of Clark County

PLANTING THE SEEDS OF RESPONSIBLE GROWTH

December 5, 2024

Clark County Council
In care of Community Planning
Dr. Oliver Orjiako, Jose Alvarez and Bart Catching
Comments on DEIS Alternatives
P.O. Box 9810
Vancouver WA 98666

RE: For Clark County Council Hearing on DEIS Alternatives

Sent via email to Rebecca.messinger@clark.wa.gov

Dear Dr. Orjiako:

My name is Mo McKenna. I am Board Member of the Friends of Clark County[1] (FOCC) Board of Directors. I am writing on behalf of the organization, our individual members, and in my personal capacity as a resident of Clark County. These comments are specific to our collective position that the Council should reject the inclusion of specific lands currently designated as AG-20 into the La Center UGA for the reasons set forth in this letter.

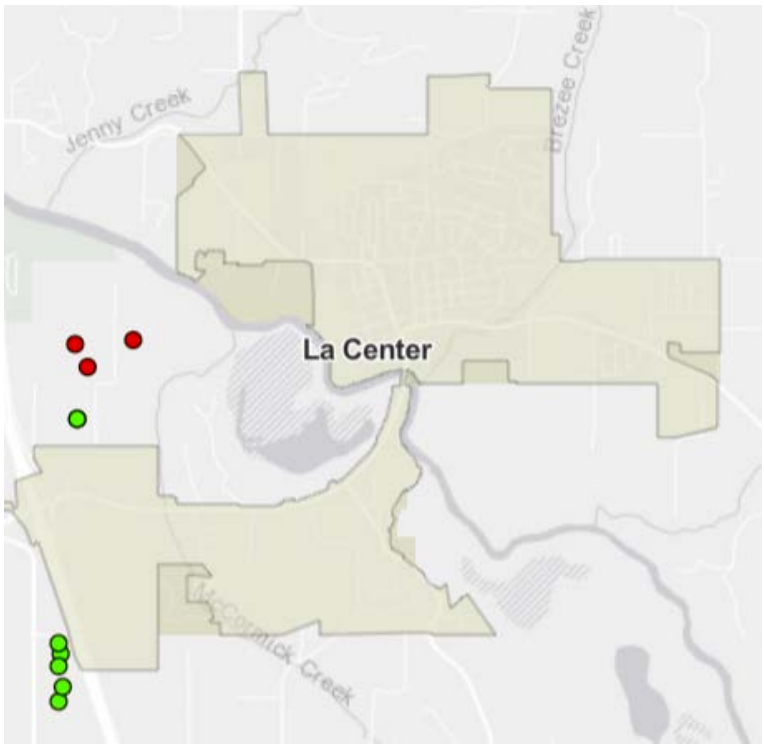
FOCC is providing the following documents in support of this comment letter:

1. Maps of Ag-20 zoned land; and
2. Soil maps for each of the areas showing the USDA farmland soil classifications; and
3. The 1972 Soil Survey of Clark County with detailed descriptions of the soil classifications to accompany the maps.

Specific Parcels

There are several site requests to be incorporated into La Center's UGA. As can be seen on the map below, there are 2 separate groups of parcels.

[1] FOCC is a 501(c)(3) Washington State non-profit corporation that works collaboratively with community partners and policy makers to keep Clark County a beautiful and healthy place to live, work, and play. FOCC works collaboratively with community partners to improve the quality of life and economic viability of our community, for all citizens of Clark County. FOCC supports smart growth that allows for economic development in balance with protecting the area's precious resources and community assets. Many members and supporters of FOCC are landowners and residents of Clark County. FOCC Board members, staff, supporters and regular members regularly participate in the many public processes by writing emails, letters, and providing testimony at public hearings concerning many land use and quality of life issues. FOCC has participated in each phase of the Comprehensive Plan update both with individual members and as an organization. We previously submitted comments on the scoping of the EIS and incorporate those comments in this letter for the record.



First Group: La Center West of I-5 NW 309th St.

The SSR comprises 5 parcels with the subject: *SSR - Request to Include Five Parcels in the La Center UGA Bound by NW 309th St. to the North; I-5 to the East, Brindle Ridge Farms to the South & NW 31st Ave. to the West*. Parcels include: 211244000, 211241000, 211265000, 211208005, 211208000

The northern and western parcels appear to be pasture and a home site including a seasonal wetland. The remaining acreage is currently being utilized as a landscape supply company and a trucking company.

- Roughly 2.5 acres are prime farmland: Gee silt loam, 0 to 8 percent slopes. Historically, Gee soils are some of the most intensively farmed soils in our county. This soil has no agricultural crop limitations and it can be used to grow anything from wine grapes to vegetables, cut flowers, nursery crops, Christmas trees, berries, fruits, and other high-value crops.
- Roughly 1 acre is farmland of statewide importance: Gee silt loam, 8 to 20 percent slopes. This soil is primarily used for hay and pasture due to the slopes, but it would also be suitable for wine grapes, fruit trees, cane berries and other perennial crops.
- Roughly 33 acres are prime farmland if drained: Cove silty clay loam, 0 to 3 percent slopes, Odne silt loam, 0 to 5 percent slopes, and Sara silt loam, 0 to 8 percent slopes. These soils are typically used for hay, pasture, and small grain.

Second SSR: La Center East of I-5 on NW 31st Ave

SSR - Sharon Woosley: Request to Rezone AG Property With an Industrial Overlay & Move into the UGB or City of La Center, Parcel # 209749000

This is a cultivated agricultural field - likely hay or small grain. The property is surrounded by farmland and forest and is in close proximity to Paradise Point Regional Park and the East Fork of the Lewis River.

- Roughly 13 acres of prime farmland: Gee silt loam, 0 to 8 percent slopes. This soil has no agricultural crop limitations and it can be used to grow anything from wine grapes to vegetables, cut flowers, nursery crops, Christmas trees, berries, fruits, and other high-value crops.
- Roughly 3.5 acres are prime farmland if drained: Odne silt loam, 0 to 5 percent slopes. These soils are typically used for hay, pasture, and small grain.
- Roughly .5 acres are farmland of statewide importance: Gee silt loam, 8 to 20 percent slopes. This soil is primarily used for hay and pasture.

Discussion

First, this letter incorporates by reference the prior letters on the DEIS alternatives submitted by FOCC, and Futurewise, to the Planning Commission as part of the official record of this Comprehensive Plan update including the letter dated December 4 , 2024 that gives extensive comments on Agricultural Lands in Clark County.

Second, Friends of Clark County, as stated in our other correspondence, our members, both individually and and collectively, want to emphasize that the County should set a goal where the Alternatives presented provide for expansion of protection and preservation of designated Agricultural Lands of long-term commercial significance rather than the loss of those lands by converting them to non-agriculture uses as is being proposed by the inclusion of approximately 700 designated agricultural lands into various proposed UGAs. Protecting and preserving existing designated agricultural lands, rather than converting them to non-agricultural uses would mean that Clark County would be in compliance with the GMA, and its legal mandates, to assure the conservation, protection and preservation of agricultural lands.

This letter adopts the legal and factual analysis in our letter dated December 4, 2024 and applies them to the City of La Center's request to convert acres of agricultural lands by incorporating them into the La Center UGA despite the fact that the existing boundaries have the capacity to accommodate all of the housing and population allocations for the City AND the City's existing boundaries can also accommodate the "jobs lands" allocation so there is no legally defensible reason to expand La Center's existing UGA much less do so just to convert legally designated agricultural lands to non-agricultural uses without complying with WAC 395-190-050 (which was amended in 2010 and 2023 both times to add greater protections for agricultural lands) and WAC 395-190-050.[2]

The same company, Johnson Economics (JE), that did a deficient and flawed "study" in Camas, and prepared equally deficient and flawed submittals for Ridgefield West (Zimmerly Property), Jones area and Rohrer area request for expansions into the City of Ridgefield proposed UGA, did the same deficient and incomplete work in this case and the work highlights non compliance with the edicts of the Growth Management Hearings Board's decision in *Clark County Citizens United et al, v. Clark County et al,* (Final Decision and Order dated March 23, 2017).

As stated in FOCC's letter to the Council regarding the proposed Ridgefield expansions, this is just another piecemeal parcelized request to convert previously designated agricultural lands of long term commercial significance without any county wide study in violation of the legal precedents, statutes and WACs.

[2] The County staff has previously sent correspondence to the cities re: compliance with CCCU v. Clark County, supra.

As stated in our letter regarding Ridgefield, in reviewing the record, it appears that the Jordan Ramis law firm first filed site specific requests on behalf of the landowners seeking to have their lands de-designated and incorporated into the proposed boundaries of Ridgefield and Camas and, now, we have also discovered in La Center. The law firm then hired JE to conduct piecemeal "studies" of the Jordan Ramis clients' properties and submit them as "de-designation" studies in almost the exact same form as was rejected by the Board in 2016. At the risk of repetition, a review of the submittals shows basically a cookie cutter template that purports to contain an "analysis" of the lands proposed for inclusion. The JE submittals, when looked at objectively, all have the same failings and are clearly written from a confirmation bias perspective. Moreover, none have been reviewed by our Community Planning or Community Development Departments for accuracy or compliance with the legal precedents, statutes and WACS. Thus, all JE submittals should be reviewed with, at best, skepticism as one must ask how all of the reports paid for by Jordan Ramis on behalf of and a variety of landowners all come to the exact same conclusions[3].

As to the requests to be included into La Center's proposed, and unnecessarily expansive, urban growth areas, the submittal by JE just ignores what is the most obvious: The lands are all agricultural lands. As with the lands in Camas and Ridgefield that JE also found to be "characterized by urban growth", one need only look at the maps and pictures, plus the current tax designations to see that none of them meet the criteria for being characterized by Urban Growth[4].

Again to repeat for the record as to the JE submittal for La Center, the GMA defines urban growth as follows:

Urban growth" ***refers to growth that makes intensive use of land for the location of buildings, structures, and impermeable surfaces to such a degree as to be incompatible with the primary use of land for the production of food, other agricultural products, or fiber, or the extraction of mineral resources, rural uses, rural development, and natural resource lands designated pursuant to RCW 36.70A.170. A pattern of more intensive rural development, as provided in RCW 36.70A.070(5)(d),*** is not urban growth. When allowed to spread over wide areas, urban growth typically requires urban governmental services. "***Characterized by urban growth" refers to land having urban growth located on it, or to land located in relationship to an area with urban growth on it as to be appropriate for urban growth.*** **(emphasis supplied)**

RCW 36.70A.030 (19)

A review of the JE submittals shows no analysis under this definition, the statute is not even referred to in the submittals nor are the prior two opinions from the Growth Management Hearings Board (Board) that addressed these exact same issues in our 2007 and 2016 updates and found against very similar, if not exactly the same, submittals as are being presented by JE. The reason seems clear: None of the lands have "***intensive use of land for the location of buildings, structures, and impermeable surfaces to such***

[3] "We find that the subject property does not meet the criteria of agricultural resource land as defined by the Washington Growth Management Act, and therefore, we recommend de-designation."

[4] In *Clark County Citizens United et al, v. Clark County et al,* the Board specifically recognized that they could simply look at the uses of the land and the maps and photos of the Clark County Lagler/Ackerland property to see that the lands were not characterized by urban growth (and cited 36.70A.030(19)): "Both the description in Appendix B and the photograph show the property is not characterized by urban growth" FDO at 79.

a degree as to be incompatible with the primary use of land for the production of food, other agricultural products"[5] .

Since the lands themselves are not characterized by urban growth, or even intensive rural growth, the JE submittals rely almost entirely on the issue of "proximity" of the lands to lands within an urban growth boundary or city limits, some as far as 2 or 3 miles away. Whereas, if one looks at the maps submitted, and the County's own GIS, all of the lands being requested for de-designations in this submittal are contiguous to swaths of AG20 lands and the rural lands that are intended to, and do, buffer those lands. In this case there are designated timber and forest lands to the northwest and south and a Rural 10 acre piece to the west that is also in Farm Agriculture designation.

Importantly, in Clark County's last failed update, the County and the landowners seeking de-designation rely heavily on the issue of "proximity" but the the Growth Management Hearings Board ruled that mere proximity to an urban area is insufficient to characterize an area as urban:

> WAC 365-190-050(3)(c)(v) lists one criteria for designating agricultural land as "[r]elationship or proximity to urban growth areas," but this does not mean that every piece of land abutting an UGA must be converted to urban uses. The Legislature intended for counties and cities to identify, designate and conserve agricultural land in RCW 36.70A.060 and that jurisdictions "shall assure that the use of lands adjacent to agricultural, forest, or mineral resource lands shall not interfere with …these designated lands for the production of food, agricultural products, or timber, or for the extraction of minerals." ***The GMA was not intended to allow a domino effect of urbanization of parcel next to parcel. Carried to its logical end, natural resource lands would never be protected. Without designating and protecting natural resource lands, there is nothing to prevent the continuing loss of these lands.***
>
> *Clark County Citizens United et al v. Clark County et al*, 16-2-0005c Final Decision and Order (March 23, 2017) at p 80. (emphasis supplied)

It is challenging to delineate all the flaws with the "study" provided by Johnson Economics (JE) but FOCC will highlight some of those flaws but asserts that the "study" should be given no weight in evaluating whether the requested parcels should be included in the La Center UGA for the reasons stated in our letter regarding agricultural lands that we submitted on December 4, 2024 and also the following reasons:

1. The submittal by JE for La Center suffers from the same failings as the submittals by JE regarding the Ridgefield and Camas UGAs as, at its core, the submittal fails to utilize and analyze the proper criteria. *Compare* Introduction at p 1 listing criteria in report with WAC 365-190-050(3)(a)-(c) and 365-190-050(5) and *Lewis County*[6].

[5] As they say, "The definition of insanity is doing the same thing over and over and expecting different results."
[6] *Lewis Cty. v. W. Washington Growth Mgmt. Hearings Bd.*, 157 Wn.2d 488, 509, 139 P.3d 1096, 1106 (2006)

2. On the face of the submittal, it does not appear to even evaluate whether the land "is capable of being used for agricultural production" which requires an evaluation using "the land capability classification system of the United States Department of Agriculture". *See* WAC 365-190-050(3)(b)(i) and (ii) and, which has already been found by Clark County and affirmed by the Board and the Courts as being based on substantial evidence.

3. In reviewing the submittal for La Center, as with JE's other submittals, one need only look at a satellite view of the property and surrounding areas along with the pictures of the area and the County's GIS maps all which show the lands as they are designated–Agricultural. With respect to all of the lands, they have previously been designated AG-20 and that designation has been upheld by the Courts and the Board and thus they are presumed to be agricultural lands of long term commercial significance. In addition, most of the lands are currently, and have been, in Current Use Farmland and Taxation, Open Space or Timberland.

4. The submittal states the criteria for "characterization of urban growth is to look "around the subject property". In this case the submittal shows that there is an equestrian stable which runs as an equestrian business on a 20 acre parcel and two other parcels that are used for landscape and equipment storage (which are by definition agricultural uses). The other characterization mentioned in the submittal involves the LaCenter UGA on the east side of the highway, the Cowlitz trust lands to the north and two planned subdivisions to the east across I5 which would have no impact and one to the south and west which has acres of Ag land in between.

5. The lands surrounding the area that are contiguous are all AG Lands and the parcels that are the subject property have both current open space and current Farm Agricultural land designations.

6. The JE submittal relies on the current economic output of the properties. However, the issue is whether or not the lands are currently economically viable but are they "capable of being used for long term production". As with the lands previously de-designated in 2007 and 2016 that the Board subsequently found did not meet the criteria for de-designation, the submittal by JE seem to harp on the intent of the landowner and ignore that these lands are capable of long term commercial production. There is some discussion regarding water rights but it is heavily couched in speculation.

7. The "study" fails to evaluate 365-190-050(5) which requires that "When applying the criteria in subsection (3)(c) of this section, **the process should result in designating an amount of agricultural resource lands sufficient to maintain and enhance the economic viability of the agricultural industry in the county over the long term; and to retain supporting agricultural businesses, such as processors, farm suppliers, and equipment maintenance and repair facilities.**" *See* Clark County Citizens United et al v. Clark County et al, FDO dated March 23, 2017 at As this Board observed in *Clark County Natural Resources Council and Futurewise v. Clark County*:

> The viability of the agricultural industry involves more than the mere conservation of land for production. There must be a significant base of land and production to support all of the agriculturally based businesses that are part of the industry, including processors, suppliers, shippers, cold storage plants, equipment repairers, and so on. In combination, the lands, producers and support businesses constitute the agricultural economy. As stated above

"natural resource lands are protected… to ensure the viability of the natural resource-based industry that depends on them". If a jurisdiction fails take a broader view, and chooses to de-designate agricultural lands on a parcel by parcel basis, it is inevitable that the jurisdiction eventually reaches a point where the agriculture production base decreases to such an extent that elements of the support industry cannot survive economically. That process continues as the production side of the industry is unable to obtain services, thus leading to further conversion of agricultural lands to non-agricultural uses. The long-term result is the disappearance of the agricultural industry.[264]

WAC 365-190-050(5) states that the final outcome of a designation process should"result in designating an amount of agricultural resource lands sufficient to maintain and enhance the ***economic viability of the agricultural industry*** in the county over the long term;and to retain supporting agricultural businesses, such as processors,farm suppliers,and equipment maintenance and repair facilities."(Emphasis added) Here, the Countyreviewed four sites and selected 602 acres within one site that may or may not have a key role to play in the agricultural industry in Clark County or the area. The County in 2004 found this land had long-term significance for agriculture when it designated the land pursuant to the requirements of RCW 36.70A.170.[265]

Following a subsequent de-designation by the County in 2007, the Boardin its Amended Final Decision and Order in Case No. 07-2-0027,found the property (then referred to as Area VB) was improperly de-designated by Clark County.That decision led to the County rescinding its de-designation.[266]There no evidence reflected in the record analyzing the effect of de-designation on the economic viability of the agricultural industry in Clark County. Also there has been no documentation of substantial changes in the land.As the Cour tof Appeals observed:

Absent a showing that this designation was both erroneous in 2004 and improperly confirmed by the Growth Board, or that a substantial change in the land occurred since the ALLTCS designation, the prior designation should remain. Without such deference to the original designation, there is no land

[264]Case No. 09-02-0002 (FDO, August 6,2009) at21.[265]*Clark County v. W. Wash.Growth Mgmt.HearingsBd.*, 161 Wn. App. 204, 234 (2011).[266]*Id.*at 227-228.

To be clear, FOCC's position is that 1) the City and the County have failed to conduct a county wide study of AG land as required by statute and rule and, 2) given the time remaining for the County to complete its work on the Comprehensive Plan update, there is insufficient time, and County resources, to conduct a thorough and comprehensive analysis of the Agricultural Lands of long term commercial significance. **Therefore, these lands should neither be considered as part of the La Center UGA as part of any DEIS alternatives, nor considered as site specific requests as doing so would violate court precedents, Board precedents, the GMA statutory scheme and the WACs.**

Best,

Mo McKenna

Board Member, Friends of Clark County

Clark County Farmer

Map Scale: 1:3,020 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Clark County, Washington
Survey Area Data: Version 22, Aug 26, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2022—Oct 11, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CvA	Cove silty clay loam, 0 to 3 percent slopes	3.5	9.3%
GeB	Gee silt loam, 0 to 8 percent slopes	2.6	6.9%
GeD	Gee silt loam, 8 to 20 percent slopes	1.3	3.4%
OdB	Odne silt loam, 0 to 5 percent slopes	7.3	19.4%
PuA	Puyallup fine sandy loam, 0 to 3 percent slopes	0.2	0.5%
SlB	Sara silt loam, 0 to 8 percent slopes	21.9	58.2%
W	Water	0.9	2.4%
Totals for Area of Interest		**37.7**	**100.0%**

MAPSONLINE
Clark County WASHINGTON

Map Sites | Find Parcel | Search | Locate Address | Find Lat/Long | Print Map | Disclaimer

Taxlot (i.e., parcel) boundaries cannot be used to determine the location of property lin

AG 20 TIMBER/FOREST

AG-20 FARM/AG

AG 20

RURAL 10 AG FARM

RURAL 5 AG FARM

RURAL 5

Map Scale: 1:3,230 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

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- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
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Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
GeB	Gee silt loam, 0 to 8 percent slopes	13.1	76.4%
GeD	Gee silt loam, 8 to 20 percent slopes	0.5	2.9%
OdB	Odne silt loam, 0 to 5 percent slopes	3.5	20.7%
Totals for Area of Interest		**17.1**	**100.0%**

SOIL SURVEY OF CLARK COUNTY, WASHINGTON

BY DALE A. McGEE, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY DALE A. McGEE, RUDOLPH W. MAYKO, WILLARD A. CALL, CARL J. McMURPHY, AND JOHN G. KRAUTSCHEID, SOIL CONSERVATION SERVICE.

UNITED STATES DEPARTMENT OF AGRICULTURE, IN COOPERATION WITH THE WASHINGTON AGRICULTURAL EXPERIMENT STATION

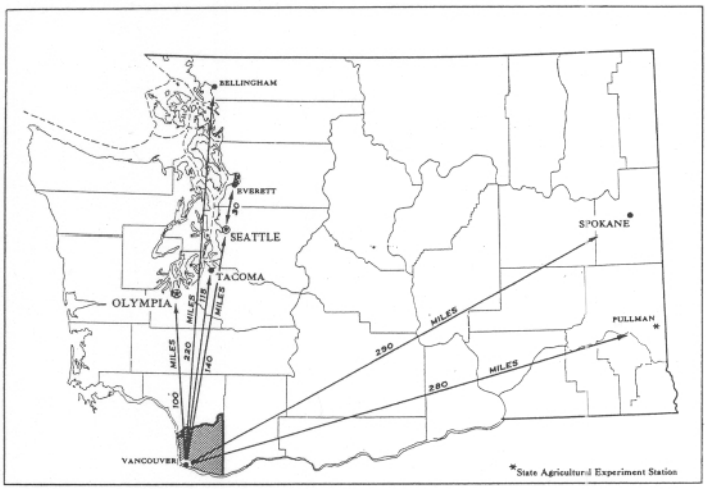

Figure 1.-Location of Clark County in Washington.

CLARK COUNTY is in the southwestern part of the State of Washington (fig. 1). The Columbia River forms its southern and western borders. It is bounded on the north by the Lewis River and on the east by Skamania County.

The land area comprises about 400,000 acres, or about 630 square miles. The population is approximately 101,000. The largest city, Vancouver, population 34,500, is the county seat and is 100 miles south of Olympia, the State capital. Vancouver is along the north shore of the Columbia River, opposite Portland, Oregon.

Economic development in Clark County is diversified. Farming is important, but it is secondary in value of total products to industrial products, which include lumber, pulp, paper, aluminum, carborundum, and chemicals. About 42 percent of the county is cleared and in farmland; the rest is forested or logged-off land. Most of the farmland lies in the central, western, and southwestern parts of the county. This area is composed of terraces and terrace plains, about 30 to 800 feet above sea level. The northern and eastern parts of the county are forested foothills and mountains of the Cascade Range. In these areas farming is confined to the larger valleys. Much of the cleared land is in hay and pasture.

Dairying is the most important farm enterprise in the county; it accounts for more than 40 percent of the value of farm products sold. Ranking second and third are livestock and poultry. Other important farm products are vegetables, berries, and orchard fruits.

The county lies in a long structural basin (Willamette-Puget Trough) between the Pacific Coast ranges to the west and the parallel Cascade Range to the east. The Columbia River, the major trunk stream of the Pacific Northwest, flows through the Cascade Range, borders Clark County as it crosses the trough, then passes through the Pacific Coast ranges into the Pacific Ocean to the west.

The western part of the county consists of a series of gently rolling alluvial terraces that form plains and benches rising steplike from the present level of the Columbia River. The elevations in these areas range from a few feet to more than 800 feet above sea level. The eastern part of the county consists of high old alluvial terraces against volcanic foothills and mountains of the western slopes of the Cascade Range. Along the eastern margin of the county, some of the higher peaks rise to an elevation of nearly 4,000 feet. Mountain ridges 2,000 to 3,000 feet in elevation are common. Much of this area is very steep, and a fall of 1,000 feet within a lateral distance of half a mile is not uncommon. The mountainous terrain is heavily dissected by streams that originate in this area and to the east. Most of the important streams that drain the county flow in a westerly direction. The more prominent streams are: the North Fork of the Lewis River; the East Fork of the Lewis River; the Washougal and Little Washougal Rivers; and Lacamas, Salmon, Big Tree, Cedar, Canyon, Mason, and Lockwood Creeks.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Clark County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the

size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the soil profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey *(16)*.

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

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

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

A comparison of the detailed soil map of this county with that of Cowlitz County will show a few places where soil boundaries between Clark County and Cowlitz County do not match perfectly. These few differences arise because the two counties are separated by the Lewis River and large manmade lakes.

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

Some mapping units are made up of soils of different series, or of different phases within one series. One such mapping unit is a soil complex. A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern; and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Hockinson-Dollar loams, 0 to 3 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Riverwash (sandy) is a land type in Clark County.

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

The soil scientists set up trial groups of soils on the basis of yield and practice tables and other data they have collected. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

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

The soil associations in Clark County are discussed in the following pages. The terms for texture used in the descriptive heading for several of the associations apply to the surface layer. For example, in the heading for association 1 the words "moderately fine textured to moderately coarse textured" refer to texture of the surface layer.

'Italic numbers in parentheses refer to Literature Cited, p. 111.

Somewhat Excessively Drained to Very Poorly Drained Soils of Bottom Lands and Terraces

These soils occupy areas in the valleys of the Columbia and Lewis Rivers and their tributaries in the western and southern parts of the county. This group makes up 41 percent of the county.

These soils are somewhat excessively drained to very poorly drained. They are mostly moderately rapidly permeable to very slowly permeable. Elevations range from less than 35 feet to about 350 feet, and annual precipitation ranges from 40 to 60 inches. The native vegetation consists of conifers, deciduous trees, native grasses, and ferns.

Four of the soil associations in this county are in this group.

1. Sauvie-Puyallup association

Deep, nearly level to gently sloping, somewhat poorly drained to somewhat excessively drained, moderately fine textured to moderately coarse textured soils of the flood plains

This association is made up of nearly level to gently rolling flood plains of the Columbia and Lewis Rivers. Drainageways and shallow depressions are numerous. Shallow lakes are common in the Columbia River bottoms. Elevations are less than 35 feet. The annual precipitation is 40 to 60 inches. The native vegetation consists mostly of willows, cottonwoods, and native grasses.

This association occupies about 7 percent of the county. Sauvie soils make up about 30 percent of the association, and Puyallup soils 15 percent. Small acreages of Pilchuck, Newberg, Cloquato, and Washougal soils make up the rest.

Sauvie soils occur chiefly on the Columbia River bottoms and where the Lewis and Washougal Rivers join the Columbia River. They developed in alluvium. These are moderately well drained and somewhat poorly drained soils that are more than 60 inches deep. They have a surface layer of very dark grayish-brown silty clay loam.

Puyallup soils occur chiefly on the Columbia River bottoms and where the Lewis and Washougal Fivers join the Columbia River, but also on the bottom lands along the Lewis River and the East Fork of the Lewis River. These soils developed in alluvium. They are somewhat excessively drained and are underlain by gravelly sand or loamy sand at a depth of about 16 to 40 inches. They have a surface layer of dominantly very dark brown fine sandy loam.

Newberg soils occur chiefly on the Columbia River bottoms and where the Lewis and Washougal Rivers join the Columbia River. Cloquato soils are on bottom lands along the East Fork of the Lewis River; Washougal soils occur on nearly level terraces along the Lewis and Washougal Rivers.

The Columbia River formerly flooded all but the higher areas on the bottom lands. Dikes now protect large acreages, and pumps are operated to maintain a low water table to offset seepage during periods of high water. Intensive crop management is practiced on the protected bottom lands. Improved pastures, row crops, and alfalfa are grown. In areas not diked, only willows, cottonwood, brush, and native grasses persist.

The protected bottom lands along the Lewis River and the East Fork of the Lewis River are important for hay, grain, and improved pasture. Areas subjected to flooding on the Lewis River support only native pasture. Much of the bottom land along the East Fork is periodically flooded and supports only native pasture, trees, and brush. The nearly level, somewhat excessively drained gravelly terraces along the Washougal and Lewis Rivers are used dominantly for woodland, but small acreages are used for hay and pasture.

This association is also used for industry and urban development, for recreational areas, and for woodland.

2. Hillsboro-Gee-Odne association

Deep, dominantly nearly level to sloping, well-drained to poorly drained, medium-textured soils of the terraces

This association is made up of nearly level to very steep soils on terraces of the Columbia and Lewis Rivers and their tributaries in the western part of Clark County. The terraces are dissected by steep-sided narrow drainageways. Elevations range from 100 to 350 feet. The annual precipitation ranges from 40 to 60 inches.

The native vegetation on the better drained sites consists mostly of Douglas-fir, grand fir, red alder, Oregon white oak, and western redcedar. The understory consists mostly of salal, Oregongrape, vine maple, and ferns. The vegetation in the wetter areas consists of red alder and Oregon ash and of water-tolerant grasses, sedges, and shrubs.

This association occupies about 14 percent of the county. Hillsboro soils make up about 50 percent of the association; Gee soils 35 percent, and Odne soils 10 percent. Sara soils make up the rest.

Hillsboro soils form a nearly continuous area between Whipple Creek and Hazel Dell; they also occur north of Whipple Creek. These are well-drained, nearly level to very steep soils that are more than 60 inches deep. They have a surface layer of very dark brown silt loam.

Gee soils are north of Whipple Creek, mainly around the communities of Ridgefield, Pioneer, and Good Hope. These are deep, moderately well drained, nearly level to very steep soils. They have a very dark grayish-brown or very dark brown silt loam surface layer.

Odne soils occur in drainageways within areas of Gee soils. These soils are deep, poorly drained, and nearly level to concave. They have a surface layer of very dark grayish-brown or very dark brown silt loam.

Hay, grain, and pasture are the major crops in this association. Dairying is the major farm enterprise. Hillsboro soils are used extensively for orchards, cane fruits. row crops, and alfalfa hay.

3. Hillsboro-Dollar-Cove association

Deep, dominantly nearly level to sloping, well-drained to very poorly drained, medium-textured to fine-textured soils of the terraces

This association is made up of nearly level to steep, undulating terraces of the Columbia River and its tributaries in the central and southeastern parts of Clark

County. Elevations range from 90 to 290 feet. The annual precipitation ranges from 40 to 55 inches.

The native vegetation on the wetter areas consists of Oregon ash and red alder and of water-tolerant grasses, sedges, and shrubs. The vegetation on the better drained sites consists of Douglas-fir, grand fir, western redcedar, bigleaf maple, and western dogwood. The understory consists of salal, ferns, Oregongrape, and vine maple.

This association occupies about 12 percent of the county. Hillsboro soils make up about 40 percent of the association; Dollar soils, 20 percent; and Cove soils, 10 percent. Small acreages of Hockinson soils and McBee, coarse variant, soils make up the rest.

Hillsboro soils form a large, nearly continuous, gently undulating area mostly southwest of Brush Prairie. These are deep, well-drained soils. They are very dark brown or very dark grayish brown and are dominantly medium textured to a depth of 60 inches.

Dollar soils occur in association with move soils, but at slightly higher elevations than those soils. These are deep, moderately well drained, nearly level soils. They are brown to very dark brown, and medium textured. They have a fragipan at a depth of 24 to 42 inches.

Cove soils are in depressions and drainageways. These are deep, poorly drained, nearly level soils. They are very dark gray to very dark grayish brown, and fine textured. They have high shrink-swell potential. A seasonally high water table at or near the surface severely limits their use for crops.

Hay and pasture are the major crops in this association. Hillsboro soils are also used extensively for cane fruits, orchards, nuts, row crops, and small grain.

4. Lauren-Sifton-Wind River association

Somewhat excessively drained, dominantly nearly level to gently sloping, gravelly, medium-textured and moderately coarse textured soils of the terraces

This association is made up of nearly level to gently rolling soils on terraces of the Columbia River in the southwestern part of Clark County. Elevations range from 150 to 300 feet. The annual precipitation ranges from 40 to 50 inches.

The native vegetation on the Lauren and Wind River soils consists of Douglas-fir, grand fir, bigleaf maple, and Oregon white oak; the understory is salal, fern, vine maple, dogwood, and hazel. The native vegetation on the Sifton soils is prairie grasses and ferns and scattered stands of Oregon white oak and Douglas-fir.

This association occupies about 8 percent of the county. Lauren soils make up about 42 percent of the association; Sifton soils, 12 percent; and Wind River soils, 10 percent. Small acreages of Hillsboro, Tisch, Semiahmoo, and other soils make up the rest.

The acreage south of Burntbridge Creek and east of Vancouver is dominated by Lauren soils. These soils are moderately deep to very gravelly coarse sandy loam. They are somewhat excessively drained, nearly level to steep, very dark brown, and medium textured,

The acreage near the greater Vancouver area is dominated by Wind River soils. These soils are moderately deep to loamy coarse sand or gravelly loamy coarse sand. They are somewhat excessively drained, nearly level to steep soils that are dark brown and moderately coarse textured.

The rest of this association is dominated by nearly level to very steep Wind River soils and nearly level Sifton soils. Sifton soils, which dominate the Orchards area, are shallow to very gravelly loamy coarse sand. They are somewhat excessively drained soils that are black and medium textured.

All the soils of this association are underlain by gravel, loamy coarse sand, or coarse sand. The available water capacity is medium to low. Without irrigation, the range of crop suitability is limited. Most of the association is in pasture, hay, and small grain. Urbanization is important in this association.

Well-Drained Soils of Mountains and Valleys

These soils occupy areas in the eastern part of the county on the western slopes of the Cascade Range. This group makes up 43 percent of the county.

These soils are deep, well drained, and mostly steep to very steep. Elevations range from about 300 feet to more than 3,000 feet, and the annual precipitation ranges from about 45 inches at the lower elevations to about 120 inches on the high ridges and peaks. Most of the precipitation at the higher elevations comes in the form of snow. The native vegetation is dominantly conifers and a few hardwoods.

Two of the soil associations in this county are in this group.

5. Cinebar-Yacolt association

Deep, dominantly gently sloping to very steep, medium-textured soils of the mountains and valleys

This association is made up of mountains and associated valley areas in the northeastern part of Clark County. Elevations range from about 300 to 2,500 feet. The annual precipitation ranges from 60 to 120 inches.

The native vegetation consists of Douglas-fir and scattered cedar, grand fir, and hemlock. The understory consists of ferns, salal, Oregongrape, vine maple, and red huckleberry.

This association occupies about 22 percent of the county. Cinebar soils make up about 60 percent of the association, and Yacolt soils 30 percent. Small acreages of Mossyrock, Minniece, and Gumboot soils make up the rest.

Cinebar soils are dominant on mountain slopes. These are deep, well-drained, gently sloping to very steep soils. They are medium textured and very dark brown.

Yacolt soils occur on valley terraces. These are deep, well-drained, nearly level to moderately sloping soils. They are medium textured and very dark brown.

A large part of this association burned over in 1902 and has burned several times since. Active reforestation and fire prevention are making the area productive again.

Most of the association is in coniferous forest. The Chelatchie Valley has been cleared and is used for hay and pasture.

6. Olympic-Kinney association

Deep, dominantly steep and very steep, moderately fine textured to medium-textured soils of the mountains

This association is in the mountainous east-central and southeastern parts of Clark County. Elevation as range from 400 feet to more than 3,000 feet. The annual precipitation ranges from 45 to 90 inches.

The native vegetation consists of Douglas-fir, grand fir, western redcedar, hemlock, and Oregon white oak. The understory consists of vine maple, salal, Oregongrape, ferns, and grasses.

This association occupies about 21 percent, of the county. Olympic soils make up about 60 percent of the association, and Kinney soils 30 percent. Small acreages of Larchmount and Bear Prairie soils make up the rest.

Olympic soils occur on mountain foot slopes at elevations of 400 to 1,600 feet. These are deep, well-drained soils. They are moderately fine textured and dark reddish brown.

Kinney soils occur on the upper mountain slopes at elevations of 1,600 to 3,000 feet. These are deep, well-drained soils. They have a medium-textured surface layer and a moderately fine textured subsoil.

Larchmount soils occur at elevations of more than 3,000 feet. Bear Prairie soils occur on high terraces in the Skye and Bear Prairie districts.

This association is suited to forest production. The area was completely burned over in 1902 and his burned several times since. Active reforestation and fire prevention are gradually reforesting the area.

Well-Drained Soils of Uplands, Mountain Foot Slopes, and Associated Terraces

These soils occupy a narrow band running diagonally from the northwestern corner of the county to the southeastern corner. This group makes up 16 percent of the county.

These soils are deep, well drained, and mostly moderately slowly permeable. Elevations range from 300 to 1,200 feet, and the annual precipitation ranges from 45 to 80 inches. The native vegetation is dominantly conifers and some hardwoods.

Two of the soil associations in this county are in this group.

7. Hesson-Olequa association

Deep, nearly level to steep, moderately fine textured to medium-textured soils of the uplands and terraces

This association is made up of dominantly high terraces and some upland areas. It occurs in the northwestern part of the county. Elevations range from about 150 feet to more than 800 feet. The annual precipitation ranges from about 50 to 65 inches.

The native vegetation consists of Douglas-fir, red alder, redcedar, and grand fir. The understory is dominantly red huckleberry and ferns.

This association occupies about 8 percent of the county.

Hesson soils make up about 50 percent of the association, and Olequa soils 10 percent. Small acreages of Olympic, Minniece, and other soils make up the rest.

Hesson soils occur on terraces at elevations of 300 to 800 feet. These are deep, well-drained, gently sloping to steep soils. They have a moderately fine textured surface layer and a moderately fine textured to fine textured subsoil. They are dark reddish brown.

Olequa soils occur on terraces at elevations of about 150 feet. These are deep, well-drained, nearly level to steep soils. They have a medium-textured surface layer and a moderately fine textured subsoil. They are very dark brown or very dark grayish brown.

Olympic soils, which make up a minor part of this association, occur on uplands.

The soils of this association are used mostly for hay, pasture, and forestry. Strawberries, cane fruits, and orchards are also important uses.

8. Hesson-Olympic association

Deep, nearly level to steep, moderately fine textured soils of the mountain foot slopes and terraces

This association is made up of mountain foot slopes and terraces. It occurs as a band 1 to 3 miles wide extending in a southeasterly direction from the vicinity of Hesson to the extreme southeastern corner of Clark County. Elevations range from 300 to 1,200 feet. The annual precipitation ranges from 45 to 80 inches.

The native vegetation consists mostly of Douglas-fir, grand fir, western redcedar, hemlock, and Oregon white oak. The understory consists of vine maple, Oregongrape, salal, ferns, and grasses.

This association occupies about 8 percent of the county. Hesson soils make up 75 percent of the association, and Olympic soils 20 percent. Small acreages of McBee soils make up the rest.

Hesson soils occur at elevations of less than 800 feet. These are deep, well-drained soils. They have a moderately fine textured surface layer and a moderately fine textured and fine textured subsoil. They are dark reddish brown.

Olympic soils occur mostly at elevations above 800 feet. These are deep, well-drained soils. They are moderately fine textured throughout and are dark reddish brown.

About half of this association is cleared and used for hay and pasture. The rest is in forest.

Descriptions of the Soils

In this section the soil series and mapping units of Clark County are described. The approximate acreage and proportionate extent of each mapping unit are given in table 1.

The series descriptions are in alphabetic order. Following each series description is a fairly detailed description of the most extensive or most important mapping unit of the series. This detailed description is followed by brief descriptions of the rest of the mapping units.

In the description of the first mapping unit of each series is a short narrative description of a profile representative of the series and a much more detailed description of the same profile from which highly technical

interpretations can be made. The descriptions of the rest of the mapping units tell mainly how these units differ from the one described in detail.

Unless otherwise stated, the color names and color symbols given are for moist soils.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. At the end of the description of each mapping unit are listed the capability unit, the woodland suitability group, and the wildlife site in which the mapping unit has been placed. The pages where these interpretive groups are described can be readily learner by referring to the "Guide to Mapping Units."

For more general information about the soils, the reader can refer to the section "General Soil Map," is which the broad patterns of soils are described. Man of the terms used in the soil descriptions and other part of the survey are defined in the Glossary.

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

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Bear Prairie Series

The Bear Prairie series consists of deep, well-drained, black soils. These soils are mostly nearly level to gently sloping, but some are undulating. These are medium-textured soils that occur mostly on high terraces in the Skye and Bear Prairie areas. They formed in parent material derived mainly from volcanic ash, pumice, and some weathered igneous rock. The native vegetation is mainly grass, bracken fern, and scattered stands of Douglas-fir. The annual precipitation is 65 to 90 inches.

Bear Prairie soils are used chiefly for timber, hay, and pasture.

Bear Prairie silt loam, 0 to 8 percent slopes (BpB).-This soil occurs on high terraces. Most slopes are smooth or gently undulating and range from 1 to 5 percent.

In a typical profile the surface layer is silt loam about 15 inches thick. It is black in the upper part and very dark brown in the lower part. The subsurface layer is dark-brown, friable silt loam about 10 inches thick. Below the subsurface layer is friable, dark yellowish-brown silt loam about 26 inches thick. The next layer, to a depth of 75 inches, is dusky-red gravelly loam.

Included in mapping were a few areas where a few scattered cobblestones and stones occur on the surface and throughout the profile. Also included were small areas of dark reddish-brown soils.

This soil is well drained, moderately permeable, and easily tilled. The available water capacity is very high. Fertility is low. Surface runoff is slow, and the erosion hazard is slight.

Representative profile of Bear Prairie silt loom under a cover of fern and scattered trees, about 200 feet northwest of County Road No. 11, about 1,100 feet south and 1,700 feet west of the northeast corner of sec. 24, T. 2 N., R. 4 F.

O1-2 1/2 inches to 1 inch, litter composed of needles, leaves, and twigs.

O2-1 inch to 0, black (10YR 2/1) decomposed organic material ; weak, fine, granular structure ; very friable, nonsticky and nonplastic ; few fine roots ; abrupt, smooth boundary. (1/2 inch to 1 inch thick)

A11-0 to 7 inches, black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, very fine, granular structure ; slightly hard, very friable, nonsticky and nonplastic ; many fine, medium, and coarse roots ; very strongly acid ; abrupt, smooth boundary. (6 to 10 inches thick)

A12-7 to 15 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, very fine, granular structure ; slightly hard, very friable, nonsticky and nonplastic ; many fine, medium, and coarse roots ; strongly acid ; clear, wavy boundary. (6 to 10 inches thick)

A3-15 to 25 inches, dark-brown (10YR 3/3) silt loam, dark brown (10YR 4/3) when dry; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; many fine, medium, and coarse roots ; many fine and medium pores ; strongly acid; clear, irregular boundary. (5 to 20 inches thick)

B21-25 to 42 inches, dark yellowish-brown (10YR 4/4) heavy silt loam, yellowish brown (10YR 5/4) when dry; weak, fine, sub angular blocky structure; slightly hard, friable, sticky and plastic ; common fine and medium roots ; common fine, and few medium pores ; strongly acid; gradual, wavy boundary. (15 to 20 inches thick)

B22-42 to 51 inches, dark yellowish-brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) when dry ; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; common, fine, fibrous roots ; many, fine, tubular pores ; few, very thin, patchy clay films on ped surfaces; strongly acid; about 10 percent angular cobblestones ; common, fine pumice grains; clear, smooth boundary. (8 to 11 inches thick)

IIC-51 to 75 inches, dusky-red (2.5YR 3/2) gravelly loam, dark reddish gray (5YR 4/2) when dry; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; few fine roots ; few, fine, tubular pores ; medium acid.

The A horizon ranges from 14 to 34 inches in thickness and commonly has weathered, shot-size pumice fragments. In places the B2 horizon has the feel of heavy silt loam or light silty clay loam.

This soil is used primarily for timber. Where cleared, it has been used for hay, pasture, and grain. Response to fertilization is poor. Christmas tree plantations are being established in many of the cleared areas. Red alder, hazel,

and Douglas-fir are encroaching into the unmanaged areas. (Capability unit IIIe-2; woodland suitability group 3oM3; wildlife site 7)

Bear Prairie silt loam, 8 to 15 percent slopes (BpC) -This soil is similar to Bear Prairie silt loam, 0 to 8 percent slopes, except that the surface layer tends to be thinner, varying from 11 to 15 inches in thickness. Runoff is medium, and the erosion hazard is moderate. Included in mapping were a few areas where the slope is more than 15 percent.

This soil is used primarily for timber. Cleared areas are used for hay and pasture.

Conservation practices, such as cross-slope tillage, are needed to help control loss of soil. Douglas-fir, grand fir, and red alder are suitable trees. (Capability unit IIIe-2 ; woodland suitability group 3oM3; wildlife site 7)

Cinebar Series

The Cinebar series consists of deep, well-drained, gently sloping to very steep soils. These are medium-textured soils that formed in material derived from volcanic ash. In places angular basalt rock is scattered throughout the profile. These soils occur in the northeastern part of the county on hilly uplands and old terraces, which are dissected by many creeks and drainageways. The native vegetation is a heavy growth of Douglas-fir and scattered cedar and hemlock. The understory consisted principally of ferns, salal, Oregongrape, red huckleberry, and vine maple. Much of the timber has been logged or burned over, and now the soils support stands of second-growth Douglas-fir. Large areas have been invaded by red alder, but much of the native understory persists. The annual precipitation ranges from 60 inches to more than 90 inches.

Cinebar soils are among the highest producing timber soils in Clark County. Where cleared and cultivated, they are used mostly for hay and pasture. The principal cultivated areas are near View, Fargher Lake, and Amboy. Hay and pasture are commonly grown, but pole beans, grain, and strawberries are also grown.

Cinebar silt loam, 8 to 20 percent slopes (CnD).-This soil is dominant in the lower foothills of the northeastern part of the county. The slopes are generally long but are dissected by many drainageways, which give the area a rolling relief.

In a typical profile the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is dark-brown, friable silt loam about 7 inches thick. Below this is friable, dark yellowish-brown silt loam about 35 inches thick. The underlying material, to a depth of 65 inches, is dark yellowish-brown loam.

Included in mapping were a few small areas that contain up to 20 percent angular gravel and cobblestones. Also included were a few small stony areas.

This soil is well drained, moderately permeable, and easily tilled. The available water capacity is very high. The fertility is moderate. Surface runoff is medium, and the erosion hazard is moderate.

Representative profile of Cinebar silt loam in woodland, 2 1/2 miles southeast of Amboy, 600 feet east of creek on south side of road, southeast corner of NE1/4SW1/4 sec. 28, T. 5 N., R. 3 E.

O1-1 1/2 inches to 1 inch, needles, twigs, and leaves.

O2-1 inch to 0, partly decomposed, brown to dark-brown needles, twigs, and leaves.

A1-0 to 6 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, fine, granular structure ; soft, very friable, nonsticky and nonplastic ; many roots ; about 40 percent reddish-brown concretions, 1 to 5 millimeters in size ; very strongly acid. (5 to 7 inches thick)

A3-6 to 13 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, fine, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; many roots ; common, fine pores ; about 30 percent concretions, 1 to 5 millimeters in size; strongly acid. (6 to 8 inches thick)

B21-13 to 24 inches, dark yellowish-brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) when dry ; weak, medium, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; many roots ; many fine pores ; common concretions, 1 to 5 millimeters in size; strongly acid. (10 to 12 inches thick)

B22-24 to 48 inches, dark yellowish-brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) when dry; weak, medium, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; few roots ; many fine pores ; medium acid. (20 to 28 inches thick)

C-48 to 65 inches, dark yellowish-brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) when dry ; massive ; slightly hard, friable, slightly sticky and slightly plastic ; few roots; many fine pores ; many transparent silica crystals less than 1 millimeter in size ; medium acid.

The A1 horizon ranges from very dark brown to very dark grayish brown in color. The texture of the B2 horizon ranges from silt loam to loam. In places this horizon feels like clay loam. The B2 horizon ranges from yellowish brown to dark yellowish brown in color. Concretions, 1 to 5 millimeters in diameter, make up 10 to 40 percent of the A horizon and are common in the upper part of the B2 horizon.

Most of this soil is used for Douglas-fir. Hay and pasture are grown on the cleared areas. Oats, barley, strawberries, and pole beans are sometimes grown in rotation with hay and pasture. (Capability unit IIIe-2; woodland suitability group 2oH3; wildlife site 7)

Cinebar silt loam, 3 to 8 percent slopes (CnB).-This soil is similar to Cinebar silt loam, 8 to 20 percent slopes, except that the surface layer is 2 to 3 inches thicker (fig 2). Surface runoff is slow, and the erosion hazard is slight.

This is the most extensively cultivated soil of the Cinebar series. The main use is for hay and pasture. The row crops are strawberries and pole beans. Oats and barley are also grown. (Capability unit IIe-3; woodland suitability group 2oH3; wildlife site 7)

Cinebar silt loam, 20 to 30 percent slopes (CnE).-This soil is similar to Cinebar silt loam, 8 to 20 percent slopes, except that the slopes are shorter. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe when the surface is left bare. In places cobblestones and gravel are scattered throughout the profile.

Included in mapping were small, stony areas.

This soil is used for Douglas-fir, but a few small areas are seeded to pasture grasses and legumes. (Capability unit IVe-4; woodland suitability group 2oH3; wildlife site 7)

Cinebar silt loam, 30 to 70 percent slopes (CnG).-This soil is similar to Cinebar silt loam, 8 to 20 percent slopes, except that the thickness of the surface layer ranges from

Figure 2.-Profile of Cinebar silt loam, 3 to 8 percent slopes. This is in an area near Amboy.

10 to 13 inches. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare. Included in mapping were a few areas that contain angular gravel and cobblestones.

This soil is suited to Douglas-fir. (Capability unit VIe-3; woodland suitability group 2rH5; wildlife site 7)

Cinebar stony silt loam, 3 to 30 percent slopes (CrE).This soil is similar to Cinebar silt loam, 8 to 20 percent slopes, except that it is stony. The stones interfere with the use of tillage machinery in most places; consequently, the soil is used mainly for Douglas-fir. A few small areas are used for pasture. The available water capacity is high. (Capability unit VIe-1; woodland suitability group 2oH3; wildlife site 12)

Cinebar stony silt loam, 30 to 70 percent slopes (CrG).-This soil is similar to Cinebar silt loam, 8 to 20 percent slopes, except that it is steep and stony. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe where the surface is left bare. The available water capacity is high.

This soil is too steep and stony for cultivation. It is used for Douglas-fir. (Capability unit VIe-4; woodland suitability group 2rH5; wildlife site 12)

Cispus Series

The Cispus series consists of somewhat excessively drained, steep and very steep soils that are moderately shallow to very cobbly sand. These are pumiceous gravelly sandy loams that developed in comparatively recent deposits of pumice and andesite from nearby Mount St. Helens. They are in the mountainous terrain that borders the Lewis River southwest of Mount St. Helens. The native vegetation is Douglas-fir, grand fir, bigleaf maple, vine maple, red alder, ferns, salal, and moss. The annual precipitation is 50 to 120 inches.

Cispus soils are used for timber.

Cispus gravelly sandy loam, 20 to 45 percent slopes (CsF).-This soil occurs on mountain side slopes. The slopes are long, and the area is dissected by deep, V-shaped canyons. In places there are rock outcrops.

In a typical profile the surface layer is about 16 inches thick. It is black gravelly sandy loam in the upper part, and very dark grayish-brown gravelly coarse sandy loam in the lower part. Below the surface layer is dark grayish-brown very gravelly coarse sandy loam about 8 inches thick. The underlying material, to a depth of 53 inches, is dark grayish-brown very cobbly sand.

This soil is somewhat excessively drained. Permeability is moderately rapid to a depth of about 2 feet, and below this depth it is very rapid. The available water capacity is moderate, and fertility is low. Runoff is medium to rapid, and the hazard of erosion is moderate to severe if the surface is left bare.

Representative profile of Cispus gravelly sandy loam in a wooded area approximately 26 miles east of Woodland, 1.4 miles east of Cougar, and about 700 feet south of road on 45 percent convex north slope, southeast corner of sec. 26, T. 7 N., R. 4 E.

A11-0 to 4 inches, black (10YR 2/1) gravelly sandy loam, dark gray (10YR 4/1) and very dark gray (10YR 3/1) when dry; weak, fine, subangular blocky structure ; soft, very friable, nonsticky and nonplastic ; many fine, medium, and coarse roots; medium acid; abrupt, wavy boundary. (2 to 4 inches thick)

A12-4 to 16 inches, very dark grayish-brown (10YR 3/2) gravelly coarse sandy loam, pale brown (10YR 6/3) when dry ; massive ; soft, very friable, nonsticky and nonplastic ; common fine and medium, and few coarse roots ; medium acid ; clear, wavy boundary. (9 to 16 inches thick)

C1-16 to 24 inches, dark grayish-brown (10YR 4/2) very gravelly coarse sandy loam, pale brown (10YR 6/3) when dry ; massive ; soft, very friable, nonsticky and nonplastic ; common fine and medium roots, and few coarse roots; medium acid; clear, wavy boundary. (7 to 9 inches thick)

IIC2-24 to 53 inches, dark grayish-brown (10YR 4/2) very cobbly sand, light gray (10YR 7/2) when dry; single grain ; loose, nonsticky and nonplastic ; plentiful fine, and few medium roots ; many pebbles and stones ; medium acid.

The All horizon ranges from black to very dark grayish brown in color. The A horizon ranges from gravelly coarse sandy loam to gravelly fine sandy loam in texture. The C1 horizon ranges from very gravelly coarse sandy loam to very gravelly fine sandy loam in texture. Reaction ranges from medium acid to slightly acid.

The steep slopes and rugged terrain limit use mainly to recreation, wildlife habitat, and forestry. Logging is difficult because of the steep slopes. (Capability unit VIe-3 ; woodland suitability group 4rL5 ; wildlife site 13)

Cloquato Series

The Cloquato series consists of deep, well-drained, nearly level soils underlain by sand or loamy sand at a depth of 40 inches or more. These are medium-textured soils that formed in loamy alluvium on low terraces and flood plains. The native vegetation is mixed deciduous and coniferous trees. The annual precipitation is 38 to 60 inches.

Cloquato soils are used for truck crops, row crops, hay, and pasture.

Cloquato silt loam, 0 to 3 percent slopes (CtA).-This soil occurs on low terraces and flood plains along streams. Some areas adjacent to streams are subject to flooding.

In a typical profile the surface layer is very dark grayish-brown silt loam about 12 inches thick. Below the surface layer is very friable, dark-brown silt loam about 28 inches thick. The next layer is dark grayish brown sandy loam about 12 inches thick. Below this is light brownish-gray sand about 20 inches thick.

This soil is well drained. It can be tilled throughout a wide range of moisture content. Permeability is moderate in the upper part of the profile, but it is moderately rapid or rapid in the lower part of the substratum. The available water capacity and fertility are high. Surface runoff is very slow, and there is little hazard of erosion. On small areas subject to overflow, diking and channel
work are necessary before intensive management can be practiced.

Representative profile of Cloquato silt loam in a pasture 1,500 feet west of the northeast corner of sec. 31, T. 5 N., R.1 E.

Ap-0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and coarse, granular structure; slightly hard, very friable, slightly sticky and slightly plastic ; many roots ; medium acid ; abrupt, smooth boundary. (6 to 9 inches thick)

A1-7 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, brown (10YR 4/3) when dry; moderate, medium and coarse, granular structure ; slightly hard, very friable, nonsticky and nonplastic; many fine roots ; many fine and medium pores ; slightly acid ; clear, smooth boundary. (4 to 8 inches thick)

C1-12 to 40 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, fine, subangular blocky structure; slightly hard, 'very friable, nonsticky and nonplastic ; common fine roots ; many fine and medium pores ; neutral ; abrupt at, smooth boundary. (20 to 32 inches thick)

IIC2-40 to 52 inches, dark grayish-brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) when dry; weak, medium, subangular blocky structure ; soft, very friable, nonsticky and nonplastic ; few fine roots ; many, fine and medium, tubular pores ; neutral ; abrupt, smooth boundary. (8 to 15 inches thick)

IIIC3-52 to 72 inches, light brownish-gray (2.5Y 6/2) sand, dark grayish brown (2.5Y 4/2) when dry; single grain; loose, nonsticky and nonplastic ; few fine roots ; neutral.

The A horizon ranges from very dark brown to very dark grayish brown in color. Reaction ranges from neutral to medium acid.

This soil is well suited to all truck crops, row crops, hay, and pasture suited to the county. (Capability unit I-1; wildlife site 2; not assigned to a woodland suitability group)

Cove Series

The Cove series consists of deep, very poorly drained, mostly nearly level soils (fig. 3). These soils have a clayey subsoil. They formed in water-laid deposits in old lakes and ponds. The native vegetation is deciduous trees, sedges, reeds, and water-tolerant shrubs and grasses.

Cove soils are used primarily for pasture.

Cove silty clay loam, 0 to 3 percent slopes (CvA).-This soil is in concave drainageways and in large, flat, old lakebeds. The slope is generally less than 1 percent.

In a typical profile the surface layer is very dark gray silty clay about 4 inches thick. Below this is firm clay about 32 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The underlying material, to a depth of 54 inches, is mottled, light olive-gray gravelly silty clay loam.

Included in mapping were small areas where the surface layer is gravelly silt loam, silty clay, or clay. Also included were areas where the subsoil is gravelly clay.

This soil is very poorly drained and very slowly permeable. Tillage is difficult. The available water capacity and fertility are low. The effective rooting depth averages less than 15 inches. Surface runoff is very slow, and pond
ing is common in winter unless drainage is provided. There is no hazard of erosion.

Representative profile of Cove silty clay loam, in a pasture about 4 miles northwest of Camas, about 100 yards southwest of field gate, in NW1/4T'E1/4 sec. 20, T. 2 N., R. 3 E.

Ap-0 to 4 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) when dry ; common, medium, distinct, yellowish-brown (10YR 5/6) mottles ; moderate, fine, subangular blocky structure ; very hard, firm, very sticky and very plastic ; many fine roots ; medium acid ; abrupt, smooth boundary. (4 to 8 inches thick)

B21g-4 to 26 inches, black (N 2/0) clay; many, medium, prominent, olive-gray (5Y 4/2) mottles; gray (N 3/0) when dry ; strong, coarse, prismatic structure breaking to weak, fine and medium, angular blocky ; extremely hard, firm, very sticky and very plastic ; few fine roots on ped surfaces ; common very fine pores ; slightly acid; abrupt, smooth boundary. (20 to 24 inches thick)

B22g-26 to 36 inches, very dark gray (N 3/0) clay, dark gray (N 4/0) when dry; many, medium, prominent, olive-gray (5Y 4/2) and olive-yellow (5Y 6/8) mottles ; strong, medium, angular blocky structure ; extremely hard, firm, very sticky and very plastic ; no roots ; common very fine pores ; slightly acid; abrupt, wavy boundary. (6 to 12 inches thick)

IIC-36 to 54 inches, light olive-gray (5Y 6/2) gravelly silty clay loam, light gray (5Y 7/2) when dry ; common, coarse, olive-yellow (5Y 6/6) mottles; massive; very hard, firm, sticky and plastic; common very

Figure 3.-Cove silty clay loam, 0 to 3 percent slopes. The soil on the ridge in the background is Lauren gravelly loam. This area is near Proebstel.

fine pores; few, medium, prominent, black (5YR 2/1) manganese stains; slightly acid.

The A horizon ranges from black to very dark gray or very dark grayish brown in color. The B horizon: ranges from black to very dark brown or very dark grayish brown in color.

Water-tolerant grasses and legumes are well suited, but these plants must also resist drought because this soil is droughty in summer. Tall fescue, meadow foxtail, birdsfoot trefoil, and white Dutch clover are suited grasses and legumes. (Capability unit Vw-1; wildlife site 9; not assigned to a woodland suitability group)

Cove silty clay loam, thin solum, 0 to 3 percent slopes (CwA).-This soil occurs in low, wet basins and depressions on terraces in the central part of the county. In most places the slope is less than 2 percent.

In a typical profile the surface layer is silty clay loam about 10 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The subsurface layer is dark-gray silty clay loam about 4 inches thick. Below this is extremely firm, black clay about 7 inches thick. The underlying material, to a depth of about 60 inches, is olive-colored silt loam.

Included in mapping were a few places where the surface layer is very dark brown and the material below a depth of 21 inches is sandy clay loam. Also included were small areas where the surface layer is gilt loam.

This soil is poorly drained and very slowly permeable. It is wet in winter and spring. Tillage is difficult. The available water capacity is moderate, and fertility is low. Surface runoff is very slow, and there is no erosion hazard.

Representative profile of Cove silty clay loam, thin solum, in a cultivated area near Hockinson, 300 feet east of the northwest corner of sec. 31, T. 3 N., R. 3 E.

Ap-0 to 6 inches, very dark grayish-brown (10YR 3/2) silty *clay* loam, grayish brown (10YR 5/2) when dry; moderate, fine and medium, granular structure ; hard, firm, sticky and plastic ; many roots ; common fine and medium pores ; very strongly acid ; abrupt, smooth boundary. (5 to 8 inches thick)

A1-6 to 10 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 5/3) when dry; moderate, fine, subangular blocky structure ; hard, firm, sticky and plastic ; few roots; common fine, and few medium pores ; few, fine, prominent, red (2.5YR) mottles and few, fine, distinct, yellowish-red (5YR 5/8) mottles; medium acid; clear, wavy boundary. (4 to 6 inches thick)

A2-10 to 14 inches, dark-gray (10YR 4/1) silty clay loam, light gray (10YR 6/1) when dry; many, medium, distinct, strong-brown (7.5YR 5/8) mottles; moderate, very fine and fine, subangular blocky structure; hard, firm, sticky and plastic ; few roots ; common medium and fine pores ; few, mostly round, black manganese concretions, 3 to 8 millimeters in diameter; strongly acid; abrupt, wavy boundary. (3 to 6 inches thick)

B2tg 14 to 21 inches, black (N 3/0) clay, gray (N 5/0) when dry; few, fine, distinct, yellowish-red (5YR 4/8) mottles ; strong, coarse, prismatic structure ; extremely hard, extremely firm, very sticky and very plastic ; few roots ; few fine and medium pores ; thick, continuous clay films on ped faces and in pores: slightly acid; abrupt, wavy boundary. (6 to 12 inches thick)

C-21 to 60 inches, olive (5Y 4/3) silt loam, pale olive (10YR 6/3) when dry; massive; hard, friable, slightly sticky and slightly plastic ; few roots ; few very fine pores; neutral.

The Al horizon ranges from very dark brown to very dark grayish brown or dark brown when the soil is moist.

Unless drainage is provided, crop production is poor and the soil is not suited to deep-rooted crops or to conifers. Clover, trefoil, fescue, ryegrass, and orchard-

grass are grown for hay and pasture. Oats are grown for grain and hay, and some barley is also grown. (Capability unit IVw-1; wildlife site 9; not assigned to a woodland suitability group)

Dollar Series

The Dollar series consists of deep, moderately well drained, nearly level to gently sloping soils. These are medium-textured soils that developed in deposits of old Columbia River alluvium. They are on low terraces that adjoin the poorly drained, depressional McBee, coarse variant, soils and the Hockinson and Cove soils. Most of the acreage is in the central part of The county near Hockinson, Brush Prairie, and Manor. The native vegetation is mainly Douglas-fir, grand fir, and some western redcedar. In areas transitional to wet soils, the vegetation is red alder and Oregon ash. The understory consists of salal, Oregongrape, vine maple, and ferns. The annual precipitation is 45 to 50 inches.

Nearly all the acreage is now cleared and cultivated. The main use is for hay and pasture, although some truck crops, grain, and row crops are grown. Dollar soils are considered good farming soils, but proper timing offarming operations is difficult. Fields generally contain areas of such poorly drained soils as McBee or Hockinson soils. If these soils are undrained, farming operations must be delayed so long that Dollar soils cannot always be farmed satisfactorily.

Dollar loam, 0 to 5 percent slopes (DoB).-This soil can be identified easily by its slightly raised relief and the scattered stands of Douglas-fir (fig. 4). Dollar loam is above the poorly drained McBee, coarse variant, soil and Hockinson and Cove soils, all of which occupy depressions.

In a typical profile the surface layer is dark-brown loam about 6 inches thick. Below this is friable heavy loam about 26 inches thick. It is dark reddish brown in the upper part and dark brown in the lower part. The next layer, to a depth of 60 inches, is very firm and brittle, dark yellowish-brown heavy loam.

This soil is moderately well drained and easily tilled. Permeability is very slow in the fragipan. The available water capacity is moderately high, and fertility is moderate. Surface runoff is slow, and the erosion hazard is slight.

Representative profile of Dollar loam, in a pasture half a mile north of Meadow Glade, 140 feet west of intersection of northeast 119th Street and northeast 112th Avenue on 199th Street, SE1/4SE1/4SE1/4 sec. 4, T. 3 N., R. 2 E.

Ap-0 to 6 inches, dark-brown (10YR 3/3) loam, dark grayish brown (10YR 4/2) when dry; moderate, very fine and fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic ; very fine roots ; many concretions as much as 1/8 inch in diameter; strongly acid; abrupt, smooth boundary. (2 to 8 inches thick)

B1-6 to 24 inches, dark reddish-brown (5YR 3/3) heavy loam, reddish brown (5YR 4/3) when dry ; moderate, fine, subangular blocky structure ; hard, friable, slightly sticky and plastic ; common fine roots ; many fine pores ; very few concretions ; strongly acid ; clear, wavy boundary. (12 to 20 inches thick)

B2-24 to 32 inches, dark-brown (7.5YR 3/4) heavy loam, brown (7.5YR 5/4) when dry; weak, medium, subangular blocky structure ; hard, friable, slightly sticky and plastic ; few very fine roots ; few very fine pores ; a number of peds are prominent, nodulelike,

Figure 4.-Hay on Dollar loam, 0 to 5 percent slopes, in the foreground; sedges on somewhat poorly drained Hockinson loam, 0 to 3 percent slopes, in the center; and Hesson clay loam, 20 to 30 percent slopes, in the background.

rounded, oblong, and brittle; no concretions; strongly acid; clear, smooth boundary. (6 to 14 inches thick)

Bxl-32 to 45 inches, dark yellowish-brown (10YE:. 3/4) heavy loam; many, medium, distinct, grayish-brown (10YR 5/2) mottles, yellowish brown (10YR 5/4) when dry; very coarse polygonal blocks, larger than 10 inches; very hard, very firm, brittle, slightly sticky and plastic ; no roots ; few very fine pores ; strongly acid; gradual, smooth boundary. (6 t) 15 inches thick)

Bx2-45 to 60 inches, loam ; similar to above horizon except that this horizon becomes less brittle and compact as depth increases; slightly plastic ; strongly acid.

The A horizon ranges from very dark brown to dark brown in color. The uppermost part of the B horizon ranges from 5YR to 10YR in hue when the soil is moist. The depth to the fragipan ranges from about 24 to 42 inches.

Most of this soil is used for crops or pasture. The areas that remain in timber are small farm woodlots. Unless the adjacent soils are drained, use of this soil is generally limited to hay and pasture. Under intensive management, tiling of Dollar soils increases production.

Grain, strawberries, potatoes, pole beans, and cucumbers can be grown when the adjoining poorly drained soils are reclaimed. A perched water table forms above the fragipan during rainy periods; thus, deep-rooted perennials are not well suited. Birdsfoot trefoil, big trefoil, and white clover are the legumes used in long-lived hay and pasture seedings. (Capability unit IIIe-4; woodland suitability group 3dH3; wildlife site 3)

Fill Land

Fill land (Fn) consists of nearly level areas that have been filled artificially with earth, trash, or both, and then smoothed over. It occurs most commonly in and around Vancouver, Camas, and Washougal. Large areas along the Columbia River waterfront have been filled in by dredging of sand and silt from the river. These areas do not have any clearly defined soil characteristics. Urban development is the primary use. (Capability unit VIIIs-1; not assigned to a woodland suitability group or a wildlife site)

Gee Series

The Gee series consists of deep, moderately well drained, rolling and hilly soils on eroded terraces. These are medium-textured soils that formed in old alluvium deposited by the Columbia River. The slopes are mostly nearly level to gently rolling, but along streams and major drainageways they are strongly sloping to very steep. Nearly all the acreage, from Salmon Creek to Sara and north to the Lewis River, is in the western and northwestern parts of the county. The native vegetation is mixed stands of Douglas-fir, grand fir, western redcedar, Oregon white oak, and red alder. The understory is salal, Oregongrape, vine maple, and ferns. The annual precipitation is 40 to 50 inches.

Gee soils are in one of the most intensively farmed areas of the county. Nearly all the soils of the series, except for the steep and very steep ones, are cleared and cultivated. Truck crops, small grains, row crops, hay, and pasture are commonly grown.

Figure 5.-An area of Gee silt loam, 0 to 8 percent slopes. The dark colored patches are Odne silt loam, 0 to 5 percent slopes. This area is near Pioneer.

Gee silt loam, 0 to 8 percent slopes (GeB).-This is the dominant soil (fig. 5) on the terraces in the western part of the county. The slopes are moderate to short and are undulating.

In a typical profile (fig. 6) the surface layer is very dark grayish-brown silt loam about 9 inches thick. The subsurface layer is dark grayish-brown silt loam about 5 inches thick. Below this is mottled, dark grayish-brown and dark-brown silt loam about 8 inches thick. The next layer, to a depth of 72 inches, is firm, mottled, dark brown silty clay loam.

Included in mapping were a few small areas where the A2 horizon is lacking and where the drainage is somewhat poor.

This soil is moderately well drained and easily tilled. Permeability is moderate in the surface layer and very slow in the lower part of the subsoil. The available water capacity is moderately high. Fertility is moderate. Surface runoff is slow, and the erosion hazard is slight.

Representative profile of Gee silt loam in a cultivated area, about 1,100 feet west and 250 feet south of the east quarter corner, in the southeast corner of clay pit, sec. 17, T. 4 N., R. 1 E.

AP-0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, coarse and medium, granular structure ; hard, friable, slightly sticky and slightly plastic ; many roots ; many coarse, medium, and fine pores ; common, coarse and medium, very dark brown concretions of shot size ; strongly acid ; abrupt, smooth boundary. (4 to 10 inches thick)

A2-9 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; few to common, distinct, fine mottles of yellowish brown (10YR 5/6) when dry; massive; very hard, friable, slightly sticky and slightly plastic ; many roots ; many coarse, medium, and fine pores ; common, coarse and medium, very dark brown concretions of shot size ; strongly acid ; clear, wavy boundary. (3 to 10 inches thick)

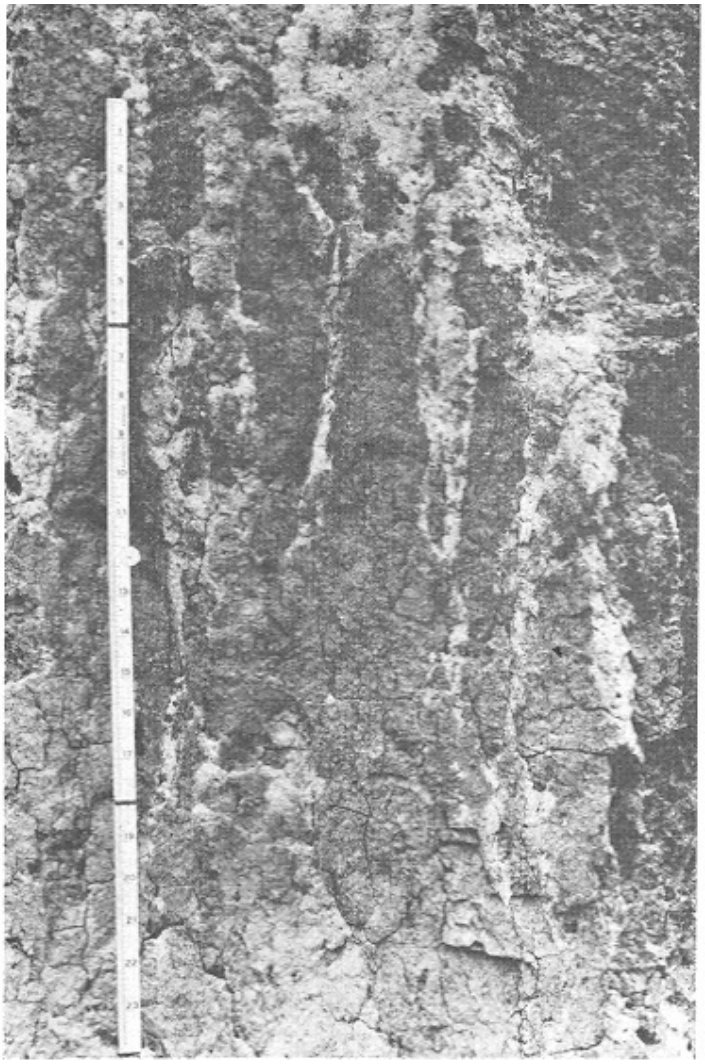

Figure 6.-Profile of Gee silt loam. This soil has gray tongues in the subsoil. It is in an area near Ridgefield.

A&B-14 to 22 inches, the A2 part of this horizon is faintly mottled, dark grayish-brown and dark-brown (10YR 4/2 and 4/3) silt loam, light brownish gray (10YR 6/2) when dry; the B part of this horizon is faintly mottled, dark-brown and dark yellowish-brown (10YR 4/4) silt loam, slightly darker (10YR 3/4) when moist ; weak, very coarse, .,prismatic structure ; very hard, friable, slightly sticky and plastic; few fine roots ; many coarse, medium, and fine pores; moderately thick, patchy clay films on surface; few common, coarse and medium, very dark brown and black concretions of shot size; strongly acid; gradual, wavy boundary. (6 to 11 inches thick)

B&A-22 to 54 inches, the B part of this horizon is dark-brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) when dry; common, medium and fine, distinct mottles of dark brown (7.5YR 3/4), black when dry ; strong, very coarse, prismatic structure breaking to strong, coarse and medium, blocky ; extremely hard, firm, sticky and plastic ; few fine and very fine pores; common coarse, medium, and fine, very dark brown and black concretions of shot size. The tongues of A2 material, which are 1/8 inch to 1 inch thick around prisms, are light-gray (10YR 7/1, dry) silt loam, grayish brown (10YR 5/2) ; hard, friable, slightly sticky and plastic; many medium and fine tubular pores ; very few medium, black and very dark brown concretions of shot size; few fine roots follow the gray tongues into this horizon; no roots penetrate interiors of prisms; moderately continuous clay films on all surfaces and in pores of the B part of this horizon ; strongly acid ; gradual, wavy boundary. (28 to 36 inches thick)

B&A2-54 to 72 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) when dry; common, fine, distinct mottles of strong brown (7.5YR 4/6) when dry ; strong, coarse and medium, prismatic structure ; extremely hard, firm, very sticky and very plastic ; surfaces of the peds and pores have thick, continuous, dark-brown (10YR 5/2) clay films; black manganese dioxide stains on peds ; around the prisms are 1/8 to 3/4 inch tongues of light gray (10YR 7/1), when dry, grayish brown (10YR 5/2) ; very few, very fine roots follow the gray tongues but do not penetrate the peds ; many coarse, medium, and fine pores ; strongly acid ; similar horizons continue to a depth of more than 10 feet.

The Ap horizon ranges from very dark grayish brown to very dark brown in color.

Most of the acreage is cultivated. Hay and pasture are the chief crops. Many other crops are grown, however, including strawberries, pole beans, potatoes, cane fruit, and corn. The perched water table that develops in the subsoil in rainy periods normally limits suitability of deep-rooted crops, such as alfalfa. Deep-rooted crops are suited to areas where the lateral drainage is good or where artificial drainage has been installed.

Red clover, white clover, and birdsfoot trefoil are the important legumes. Ryegrass, tall fescue, and orchardgrass are the important grasses. (Capability unit IIIe-4; woodland suitability group 3dH3; wildlife site 4)

Gee silt loam, 8 to 20 percent slopes (GeD).-This soil is similar to Gee silt loam, 0 to 8 percent slopes, except that the surface layer is 1 to 3 inches thinner. Sidehill seeps are common on these slopes in winter and spring. Surface runoff is medium, and the erosion hazard is moderate.

Most of this soil is cultivated. It is used less intensively than Gee silt loam, 0 to 8 percent slopes, and most of the acreage is in hay and pasture. The strong slopes limit suitability for other crops. (Capability unit IIIe-1; woodland suitability group 3dH3 ; wildlife site 4)

Gee silt loam, 20 to 30 percent slopes (GeE).-This soil is similar to Gee silt loam, 0 to 8 percent slopes, except that the surface layer is 2 to 4 inches thinner. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe if the surface is left bare.

Only a little of the acreage is cultivated. Most of it is in woodland. (Capability unit IVe-4; woodland suitability group 3dH3; wildlife site 4)

Gee silt loam, 30 to 60 percent slopes (GeF).-This soil is similar to Gee silt loam, 0 to 8 percent slopes, except that the surface layer is 2 to 4 inches thinner. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe if the surface is left bare.

This soil is suited to Douglas-fir. (Capability unit VIe-3; woodland suitability group 3rH4; wildlife site 4)

Gumboot Series

The Gumboot series consists of deep, poorly drained, nearly level to gently sloping soils. In a few areas, on the sides of drainageways, the soils are strongly sloping.

These are medium-textured soils that are moderately fine textured below the surface laver. They formed in alluvium derived from mixed ash and basic igneous rocks. Most of the acreage is along drainageways n the northeastern part of the county. The native vegetation is mainly red alder, redcedar, western hemlock, grand fir, vine maple, ferns, skunkcabbage, and mosses. Elevations are generally above 1,000 feet. Rainfall amounts to more than 85 inches annually.

The principal use of these soils is for timber. Water-tolerant trees, such as redcedar, red alder, western hemlock, and grand fir, are suited.

Gumboot silt loam, 0 to 8 percent slopes (GuB).-This soil occurs in drainageways. In most places the slope is 0 to 5 percent.

In a typical profile the surface layer is silt loam about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsurface layer is very dark gray silt loam about 2 inches thick. Below the subsurface layer is firm, mottled, dark-gray gravelly silty clay loam about 7 inches thick. The next layer is firm, mottled, gray clay loam about 31 inches thick. Below this, to a depth of 60 inches, is very gravelly silty clay.

Included in mapping were areas where the surface layer is gravelly or cobbly. Included in mapping were strongly sloping areas along the edges of drainage ways.

This soil is poorly drained, very slowly permeable, and easily tilled. The available water capacity is high, and fertility is low. Surface runoff is slow, and there is no erosion hazard.

Representative profile of Gumboot silt loam in woodland about 330 feet south and 330 feet west of the east quarter corner of the NE1/4NE1/4SE1/4 sec. 34, T. 5 N., R. 4 E.

A11--0 to 6 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) when dry; moderate, fine and medium, granular structure; soft, very friable, nonsticky and nonplastic ; many fine, medium, and coarse roots very strongly acid; abrupt, smooth boundary. (5 to 6 inches thick)

A12-6 to 10 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; weak, medium, subangular blocky structure ; slightly hard, very friable, nonsticky and nonplastic ; many fine,, medium, and coarse roots ; medium acid; clear, wavy boundary. (3 to 5 inches thick)

A2-10 to 12 inches, very dark gray (10YR 3/1) silt loam, light gray (10YR 6/1) when dry ; massive; slightly hard, very friable, slightly sticky and slightly plastic ; common fine and medium roots ; many very fine and fine pores; neutral; abrupt, wavy boundary. (2 to 3 inches thick)

B2g-12 to 19 inches, dark-gray (5Y 4/1) gravelly silty clay loam, light gray (5Y 6/1) when dry; common, coarse, prominent, reddish-brown (5YR 4/4) mottles; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic ; few, fine, fibrous roots ; common, very fine, tubular pores ; slightly acid ; clear, wavy boundary. (6 to 8 inches thick)

B3g-19 to 28 inches, gray (5Y 6/1) clay loam, light gray (5Y 7/1) when dry; common, coarse, prominent, yellowish-red (5YR 5/6) mottles; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky ; bard, firm, sticky and plastic ; few, fine, fibrous roots ; common fine pores ; 10 percent fine pumice grains 1 to 2 millimeters in size ; slightly acid ; clear, wavy boundary. (7 to 10 inches thick)

Clg-28 to 50 inches, gray (5Y 5/1) clay loam, light gray (5Y 7/1) when dry; common, coarse, prominent, yellowish-red (5YR 5/6) mottles; massive; hard, firm, sticky and plastic ; few, fine, fibrous roots ; neutral; abrupt, wavy boundary. (20 to 22 inches thick)

C2-50 to 60 inches, very gravelly silty clay ; water table.

When the soil is moist, the A11 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The Bg horizon ranges from 2.5Y to 5Y in hue. Pumice grains occur through out the profile, but the content is not more than 10 percent. The depth to very gravelly material is more than 40 inches.

The high rainfall, short growing season, and position of this soil limit its use. Red alder, western hemlock, redcedar, and grand fir are suited. If cleared and artificially drained, the soil is suited to grain, pasture, or hay. (Capability unit IVw-1; woodland suitability group 4wL3 ; wildlife site 9)

Hesson Series

The Hesson series consists of deep, well-drained soils that are mostly level to gently rolling. Some areas are hilly and very steep. These are moderately fine textured soils that have a fine textured subsoil. The parent material is deeply weathered, mixed old alluvium that contains varying amounts of gravel. The original vegetation is a heavy growth of Douglas-fir and a scattering of western redcedar and grand fir. The understory consists principally of vine maple, salal, Oregongrape, ferns, and red huckleberry. All the acreage has been logged. Areas not in cultivation are in second-growth timber. The understory is similar in composition to that of the native stands. Red alder is dominant in some areas. The annual precipitation ranges from 50 inches to more than 60 inches.

Large acreages of these soils are in cultivation. The principal crops are hay, pasture, and small grain. Some oats and corn for silage are grown in rotation with grasses and legumes. Strawberries and other truck crops are grown to some extent.

Hesson clay loam, 0 to 8 percent slopes (HcB).-This is the dominant soil of the high terraces along the mountain foot slopes in the county. In most places the slope is 2 to 5 percent. The relief is undulating. Slopes are generally short to moderate in length.

In a typical profile the surface layer is dark reddish brown clay loam about 8 inches thick. The subsurface layer is dark reddish-brown clay loam about 4 inches thick. Below this layer is friable, dark reddish-brown clay loam about 10 inches thick. The next layer, to a depth of about 91 inches, is reddish-brown clay. In sequence from the top, the uppermost 18 inches is friable, the next 39 inches is firm, and the lower 12 inches is very firm.

Included in mapping were some areas that are nearly level or are slightly depressional and have a slightly mottled layer at a depth of 30 to 40 inches. This indicates reduced permeability and a temporary perched water table during rainy periods.

This soil is well drained and has moderately slow permeability. The available water capacity is high, and fertility is moderate. Problems arise in the proper scouring of tillage equipment when the soil is worked at about field capacity. Tillage is difficult when the surface layer is nearly dry. Surface runoff is slow, and the erosion hazard is slight.

Representative profile of Hesson clay loam in a brush pasture near northeast 212th Avenue about 1,050 feet south and 200 feet west of the northeast corner of sec. 32, T. 3 N., R. 3 E.

A1-0 to 8 inches, dark reddish-brown (5YR 2/2) clay loam, dark brown (7.5YR 4/2) when dry; strong, very fine and fine, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine and medium roots ; very strongly acid ; clear, smooth boundary. (5 to 9 inches thick)

A3-8 to 12 inches, dark reddish-brown (5YR 3/2) clay loam, brown (7.5YR 5/4) when dry; strong, fine, subangular blocky structure ; slightly hard. friable, slightly sticky and slightly plastic ; many fine and medium roots ; medium acid; clear, smooth boundary. (4 to 9 inches thick)

Blt-12 to 22 inches, dark reddish-brown (5YR 3/3) clay loam, dark brown (7.5YR 4/4) when dry; moderate, medium, subangular blocky structure ; slightly hard, friable, sticky and plastic ; common fine roots ; common fine and medium pores ; moderately thick, continuous clay films on ped surfaces and in pores; strongly acid; clear, wavy boundary. (8 to 12 inches thick)

B21t-22 to 30 inches, reddish-brown (5YR 4/4) clay, brown (7.5YR 4/4) when dry; moderate, medium, subangular blocky structure ; slightly har3, friable, sticky and plastic ; common fine roots ; common fine and medium pores ; moderately thick, continuous clay films on ped surfaces and in pores ; few, medium, prominent, black (5YR 2/1) manganese stains; strongly acid; gradual, wavy boundary. (6 to 10 inches thick)

B22t-30 to 40 inches, reddish-brown (5YR 4/3) clay, brown (7.5YR 5/4) when dry; moderate, medium, prismatic structure ; slightly hard, friable, sticky and plastic ; few fine roots on ped surfaces ; common medium pores ; moderately thick, continuous clay films on ped surfaces and in pores ; few, medium, prominent, black (5Y 2/1) manganese stains. ; strongly acid ; gradual, wavy boundary. (8 to 11 inches thick)

B23t-40 to 51 inches, reddish-brown (5YR 4/3) clay, brown (7.5YR 5/4) when dry; moderate fine, prismatic structure breaking to moderate, medium, subangular blocky; hard, firm, sticky and plastic ; few fine roots on ped surfaces ; common medium and fine pores ; moderately thick, continuous clay films on ped surfaces and in pores ; few, medium, prominent, black (5YR 2/1) manganese stains; very strongly acid ; gradual, wavy boundary. (8 to 12 inches thick)

B24t-51 to 60 inches, reddish-brown (5YR 4/3) clay, brown (7.5YR 4/4) when dry; moderate, medium, prismatic structure ; hard, firm, sticky and plastic ; few fine roots on ped surfaces ; common fine and medium pores ; moderately thick, continuous clay films on ped surfaces and in pores; very strongly acid; gradual, wavy boundary. (7 to 11 inches thick)

B25t-60 to 69 inches, reddish-brown (5YR 4/3) clay, brown (7.5YR 4/4) when dry; moderate, medium, prismatic structure ; hard, firm, sticky and plastic ; no roots ; common medium and fine pores ; moderately thick, continuous clay films on ped surfaces and in pores; strongly acid; clear, wavy boundary. (7 to 11 inches thick)

B26t-69 to 79 inches, reddish-brown (5YR 4/3) clay, brown (7.5YR 4/4) when dry; moderate, coarse, prismatic structure ; very hard, firm, sticky and plastic ; common medium and coarse pores ; moderately thick, continuous clay films ; very strongly acid ; clear, smooth boundary. (6 to 12 inches thick)

B27t-79 to 91 inches, reddish-brown (5YR 4/3) clay; brown (7.5YR 4/4) when dry; common, medium, distinct, brown (10YR 5/3) mottles; moderate, coarse, prismatic structure; very hard, very firm, sticky and plastic ; common coarse pores ; moderately thick, patchy clay films on ped surfaces and medium, continuous clay films in pores; few, medium, prominent, black (5YR 2/1) manganese stains; strongly acid.

The A horizon ranges from dark reddish brown to dark brown in color. A few well-rounded quartzite pebbles occur throughout the profile.

Most of the acreage is cultivated. Hay and pasture are the chief crops, although other crops are grown, including strawberries, tree fruit, cane fruit, corn, and small grain. Red clover, white clover, subterranean clover, and birdsfoot trefoil are the common legumes. Tall fescue, ryegrass, and orchardgrass are the common grasses. Alfalfa is not well suited, because of the strong acidity and the low content of available calcium and phosphorus. (Capability unit IIe-4 ; woodland suitability group 3dH3 ; wildlife site 7)

Hesson gravelly clay loam, 0 to 8 percent slopes (HgB).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that tillage is more difficult. Permeability is moderately slow, and the available water capacity is high.

Hay and pasture are the chief crops, although other crops are grown, including strawberries, tree fruit, cane fruit, corn, and small grain. Red clover, white clover, subterranean clover, and birdsfoot trefoil are the common legumes. Tall fescue, ryegrass, and orchardgrass are the common grasses. Alfalfa is not well suited, because of the strong acidity and the low content of available calcium and phosphorus. (Capability unit IIe-4; woodland suitability group 3dH3; wildlife site 7)

Hesson clay loam, 8 to 20 percent slopes (HcD).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer generally is 1 to 2 inches thinner. In places where erosion has been active, the surface layer is 2 to 4 inches thinner. The slopes are generally single and are moderate in length.

Most areas of this soil are cleared and in cultivation, but use is less intensive than on Hesson clay loam, 0 to 8 percent slopes. Runoff is medium, and the erosion hazard is moderate where the surface is left bare in winter. Most of the acreage is in hay and pasture because the slope limits use for other crops. (Capability unit IIIe-1; woodland suitability group 3dH3; wildlife site 7)

Hesson gravelly clay loam, 8 to 20 percent slopes (HgD).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer is gravelly and the subsoil contains more gravel. Surface runoff is medium, and the erosion hazard is moderate. The available water capacity is moderate.

This soil is used less intensively than Hesson clay loam, 0 to 8 percent slopes. (Capability unit IIIe-1; woodland suitability group 3dH3; wildlife site 7)

Hesson clay loam, 20 to 30 percent slopes (HcE).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer is 2 to 3 inches thinner. Included in mapping were some areas where the surface layer is gravelly clay loam. The slopes are generally moderate in length where they lead into drainageways, but they are longer on the terrace breaks. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe where the surface is left bare in winter.

Little of this soil is cultivated. Cleared areas are mostly in pasture or hay. (Capability unit IVe-4; woodland suitability group 3dH3; wildlife site 7)

Hesson clay loam, 30 to 55 percent slopes (HcF).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer is 2 to 4 inches thinner. Included in mapping were some areas where the surface layer is gravelly clay loam. This soil occurs on terrace breaks that lead into valleys. The slopes are long. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe where the surface is left bare.

This soil is too steep for cultivation, but it is suited to timber. (Capability unit VIe-3; woodland suitability group 3rH4; wildlife site 7)

Hesson very stony silty clay loam, 3 to 30 percent slopes (HhE).-This soil is in areas where local volcanic lava flows have deposited igneous rocks over the surface. It is generally near areas of Olympic soils. Included in mapping were a few areas where the slope is more than 30 percent and a few areas that are less than 3 feet deep to weathered gravel, cobblestones, and clay. Surface runoff is slow to rapid, and the erosion hazard is slight to severe if the surface is left bare.

This soil is suited to timber (Capability unit VIs-1; woodland suitability group 3dH3 ; wildlife site 12)

Hillsboro Series

The Hillsboro series consists of deep, well-drained soils on terraces. These are medium-textured soils that developed in deposits of old Columbia River alluvium. Most areas are nearly level to gently sloping, but strongly sloping to very steep areas are along drainageways and streams. Most areas are in the southwestern, central, and south-central parts of the county. The native, vegetation is dominantly Douglas-fir and a scattering of grand fir, bigleaf maple, and western dogwood. The understory consists principally of salal, ferns, Oregongrape, and vine maple. The annual precipitation is 40 to 50 inches.

Hillsboro soils are among the most productive terrace soils in the county; about 90 percent of the acreage is cultivated. These soils are used extensively for high-income crops, such as pole beans, strawberries, sweet corn, cucumbers, and other truck crops, and for hay and pasture. They are also used for urban development.

Hillsboro silt loam, 3 to 8 percent slopes (HoB).-This is the dominant soil in the southwestern part of the county. The relief is gently undulating. In most places the slopes are short.

In a typical profile the surface layer is dark-brown silt loam about 7 inches thick. The next layer is about 48 inches thick. In sequence from the top, the upper 17 inches is friable, dark-brown silt loam; the next 16 inches is friable, dark grayish-brown heavy silt loam; and the lower 15 inches is friable, dark grayish-brown silt loam. The next layer, to a depth of 86 inches, is dark grayish brown silt loam.

Included in mapping were areas between Whipple and Salmon Creek where the texture of the surface layer is nearly clay loam.

This soil is well drained, moderately permeable, and easily tilled. The available water capacity is very high. Fertility is moderately high. Surface runoff is slow, and the erosion hazard is slight.

Representative profile of Hillsboro silt loam, in a cultivated area 600 feet east of U.S. 99 and 350 feet north of 104th Street, 3 miles north of Vancouver, SE1/4NE1/4SW1/4 sec. 35, T. 3 N., R. 1 E.

Ap-0 to 4 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 5/3) when dry; weak, very fine, granular structure ; soft, very friable, nonsticky and slightly plastic; no roots; strongly acid (pH 5.5) ; abrupt, smooth boundary. (3 to 6 inches thick)

A1-4 to 7 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 5/3) when dry ; massive ; hard, firm, slightly sticky and slightly plastic ; few fine roots ; many very fine and medium, and few coarse, tubular and interstitial pores ; strongly acid (pH 5.5) ; clear, smooth boundary. (2 to 4 inches thick)

B1-7 to 17 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 5/3) when dry; weak, medium and coarse, subangular blocky structure ; slightly hard, friable, sticky and plastic ; few fine roots ; many, very fine, tubular and interstitial pores ; thin, patchy clay films on ped surfaces; medium acid (pH 5.6) ; gradual, smooth boundary. (7 to 12 inches thick)

B21t-17 to 24 inches, dark-brown (10YR 3/3) heavy silt loam, brown (10YR 5/3) when dry; moderate, coarse, subangular blocky structure ; hard, friable, sticky and plastic ; very few, fine, fibrous roots ; many, fine, tubular and interstitial pores ; moderately thick, patchy clay films on ped surfaces and in pores ; strongly acid (pH 5.5) ; gradual, smooth boundary. (7 to 11 inches thick)

B22t-24 to 32 inches, dark grayish-brown (10YR 4/2) heavy silt loam, light brownish gray (10YR 6/2) when dry; moderate, medium and coarse, subangular blocky structure ; very hard, friable, sticky and plastic ; very few fine roots ; many, very fine, tubular and interstitial pores ; moderately thick, continuous clay films; strongly acid (pH 5.4) ; gradual, smooth boundary. (7 to 11 inches thick)

B23t-32 to 40 inches, dark grayish-brown (10YR 4/2) heavy silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky ; very hard, friable, slightly sticky and plastic ; no roots ; common, very fine, tubular pores ; moderately thick, patchy clay films on ped surfaces and moderately thick, continuous clay films in pores; very strongly acid (pH 5.0) ; gradual, smooth boundary. (6 to 12 inches thick)

B3t-40 to 55 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, coarse, subangular blocky structure ; very hard, friable, slightly sticky and slightly plastic ; no roots ; common, very fine, interstitial pores ; moderately thick, patchy clay films ; strongly acid (pH 5.1) ; gradual, smooth boundary. (12 to 20 inches thick)

C1-55 to 72 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; few, fine, faint, dark-brown (7.5YR 4/2) mottles; massive ; hard, friable, nonsticky and nonplastic ; many, very fine, tubular pores ; thin clay films in pores; strongly acid (pH 5.3) ; gradual, smooth boundary. (12 to 20 inches thick)

C2-72 to 86 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; few, fine, faint, dark-brown (7.5YR 4/2) mottles; massive ; hard, friable, nonsticky and nonplastic ; common, very fine, tubular pores ; strongly acid (pH 5.5).

The A1 horizon ranges from very dark brown to dark brown in color. The B horizon ranges from 10YR to 7.5YR in hue and from 2 to 4 in chroma. In places the profile is loam to a depth of about 36 inches, sandy loam to a depth of 48 inches, and sand between 48 and 62 inches.

Most of the acreage of this soil is cultivated or in urban fringe development. Nearly all the crops suited to this area are grown. Pears, caneberries, strawberries (fig. 7), pole beans, potatoes, and walnuts are important truck crops. Alfalfa and red clover are important

Figure 7.-Strawberries on a Hillsboro silt loam. This area is near Salmon Creek.

legumes for hay, and white clover is important for pasture. Orchardgrass and ryegrass are the chief grasses for hay and pasture. (Capability unit IIe-1; woodland suitability group 2oL3 ; wildlife site 3)

Hillsboro loam, 0 to 3 percent slopes (HlA).-This soil is similar to Hillsboro silt loam, 3 to 3 percent slopes, except that the surface layer is 1 to 3 inches thicker, and the texture is loam to a depth of about 36 inches, sandy loam between a depth of 36 and 48 inches, and sand between a depth of 48 and 62 inches. Surface runoff is very slow, and the hazard of erosion is none to slight.

Where cultivated for a number of years, this soil tends to develop a tillage pan. Deep plowing or use of a subsoiler will alleviate this condition. The available water capacity is high.

Most of this soil is used for crops and pasture. Pole beans, strawberries, potatoes, and cucumbers are grown. Alfalfa or a mixture of red clover and ryegrass for hay is commonly grown in rotation with the cash crops. There is a small acreage of cane and tree fruits. (Capability unit I-2; woodland suitability group 3oH3; wildlife site 3)

Hillsboro loam, 3 to 8 percent slopes (HlB).-This is the dominant terrace soil in the central part of the county. It is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the profile is loam to a, depth of about 36 inches, sandy loam between a depth of 36 and 48 inches, and sand between a depth of 48 and 62 inches.

Where cultivated for a number of years, this soil tends to develop a tillage pan. Deep plowing or use of a subsoiler will alleviate this condition. The available water capacity is high.

Most of this soil is used for crops and pasture. Pole beans, strawberries, potatoes, and cucumbers are grown. Alfalfa or a mixture of red clover and ryegrass for hay is commonly grown in rotation with the truck crops. There is a small acreage of cane and tree fruits. (Capability unit IIe-1; woodland suitability group 3oH3 ; wildlife site 3)

Hillsboro loam, 8 to 15 percent slopes (HlC).-This soil is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface laver is 1 to 3 inches thinner, and the texture is loam to a depth of about 36 inches, sandy loam between a depth of 36 and 48 inches, and sand between a depth of 48 and 62 inches. Surface runoff is medium, and the erosion hazard is moderate. The slopes are complex and rather short.

Pole beans, strawberries, potatoes, and cucumbers are grown. Alfalfa or a mixture of red clover and ryegrass for hay is commonly grown in rotation with the cash crops. There is a small acreage of cane and tree fruits.

Cross-slope seeding and winter cover crops help control erosion. The available water capacity is high. (Capability unit IIIe-5; woodland suitability group 3oH3; wildlife site 3)

Hillsboro loam, 15 to 20 percent slopes (HlD).-This soil is along the edge of drainageways and streams. It is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the slopes are longer, and the texture is loam to a depth of about 36 inches, sandy loam between a depth of 36 and 48 inches, and sand between a depth of 48 and 62 inches. Surface runoff is medium, and the erosion hazard is moderate.

Grasses and legumes are more common on this soil than other crops.

Use of machinery is difficult because of the slopes. Conservation practices, such as cross-slope seeding, and the use of long-lived grasses and legumes in the rotation are needed to control loss of soil. The available water capacity is high. (Capability unit IIIe-5; woodland suitability group 3oH3; wildlife site 3)

Hillsboro loam, 20 to 30 percent slopes (HlE).-This soil is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface layer is 1 to 3 inches thinner, and the texture is loam to a depth of about 36 inches, sandy loam between a depth of 36 and 48 inches, and sand between a depth of 48 and 62 inches. It occurs along the edges of drainageways and streams. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe if the surface is left bare through the winter.

Pasture is the main use where this soil is cleared. Uncleared areas are used primarily for timber production. The available water capacity is high. (Capability unit IVe-2; woodland suitability group 3oH3; wildlife site 3)

Hillsboro loam, 30 to 50 percent slopes (HlF).-This soil occurs along Salmon Creek and its tributaries. It is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface layer is 2 to 4 inches thinner, and the texture is loam to a depth of about 36 inches, sandy loam between a depth of 36 and 48 inches, and sand between a depth of 48 and 62 inches. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe if the surface is left bare in winter.

This soil is suited to timber.

The available water capacity is high. (Capability unit VIe-3 ; woodland suitability group 3rH4; wildlife site 3)

Hillsboro silt loam, 0 to 3 percent slopes (HoA).-This soil is similar to Hillsboro silt loam, 3 to S percent slopes. Surface runoff is very slow, and there is no erosion hazard.

Most of the acreage of this soil is cultivated or in urban fringe development. Nearly all the crops suited to this area are grown. Pears, caneberries, strawberries, pole beans, potatoes, and walnuts are important truck crops. Alfalfa and red clover are important legumes for hay, and white clover is important for pasture. Orchardgrass and ryegrass are the chief grasses for hay and pasture. (Capability unit I-2; woodland suitability group 2oL3; wildlife site 3)

Hillsboro silt loam, 8 to 15 percent slopes (HoC).-This soil is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface layer is 1 to 3 inches thinner. Surface runoff is medium, and the erosion hazard is moderate. Host of the slopes are short.

Nearly all the crops suited to this area are grown. Pears, caneberries, strawberries, pole beans, potatoes, and walnuts are important cash crops. Alfalfa and red clover are the important legumes for hay, and white clover for pasture. Orchardgrass and ryegrass are the chief grasses for hay and pasture.

This soil is easily cultivated. Cross-slope tillage and grasses and legumes in the rotation are needed to control erosion. (Capability unit IIIe-5; woodland suitability group 2oL3 ; wildlife site 3)

Hillsboro silt loam, 15 to 20 percent slopes (HoD).-This soil is along streams and major drainageways. It is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface layer is 2 to 3 inches thinner. Surface runoff is medium, and the erosion hazard is moderate.

Most of the crops grown on Hillsboro silt loam, 3 to 8 percent slopes, are grown on this soil. More long-lived grasses and legumes are grown because the steeper slopes create an erosion hazard and difficulty in operation of machinery. (Capability unit IIIe-5 ; woodland suitability group 2oL3 ; wildlife site 3)

Hillsboro silt loam, 20 to 30 percent slopes (HoE).-This soil is along Salmon Creek, Whipple Creek, and other major drainageways in the western part of Clark County. It is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface layer is 2 to 4 inches thinner. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe if the surface is left bare.

Most of the crops grown on Hillsboro silt loam, 3 to 8 percent slopes, are grown on this soil. More of the acreage is used for long-lived grasses and legumes because of the moderately steep slopes. (Capability unit IVe-2; woodland suitability group 2oL3; wildlife site 3)

Hillsboro silt loam, 30 to 65 percent slopes (HoG).This soil is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that the surface layer is 7 to 10 inches thick. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe if the surface is left bare.

This soil is suited to Douglas-fir. (Capability unit VIe-3 ; woodland suitability group 2rL5 ; wildlife site 3)

Hillsboro bouldery silt loam, 3 to 8 percent slopes (HsB).-Most of the acreage of this soil is on terraces along the Columbia River. The soil is similar to Hillsboro silt loam, 3 to 8 percent slopes, except that it is bouldery on the surface. Included in mapping were a few areas steeper than 8 percent. The available water capacity is high.

The soil in most places is too bouldery to be cultivated. The boulders range in weight from a few hundred pounds to several tons. They can be removed only at considerable cost. Much of the acreage is view property and is gradually developing into residential use. (Capability unit Vs-1; wildlife site 12; not assigned to a woodland suitability group)

Hockinson Series

The Hockinson series consists of deep, moderately well drained and somewhat poorly drained, nearly level to gently sloping soils on terraces. These are loamy soils that formed in old alluvium of mixed origin. Nearly all the acreage is near Hockinson and Battle Ground, but some of the acreage is near Manor. The native vegetation on Hockinson soils is Oregon ash, Oregon white oak, western redcedar, red alder, hardhack, sedges, and water-tolerant grasses. The average annual precipitation is between 50 and 60 inches.

About 95 percent of the acreage has been cleared, and the soils are used chiefly for hay and pasture. In areas that are artificially drained, irrigated pasture, and some row crops, such as cucumbers, pole beans, and potatoes, are grown. Crops that require spring planting cannot be grown unless the soils are drained. Without artificial

drainage, only water-tolerant grasses and legumes can be grown.

Hockinson loam, 0 to 3 percent slopes (HtA).-This soil is in the central part of Clark County. In most places the slope is less than 2 percent.

In a typical profile the surface layer is mottled, very dark gray loam about 6 inches thick. The next layer is about 35 inches thick. In sequence from the top, the upper 17 inches is friable, mottled, dark-gray loam; the next 7 inches is firm, mottled, dark-gray fine sandy loam ; and the lower 11 inches is firm, mottled, very dark grayish-brown loam. Below this is dark grayish-brown loam about 10 inches thick. The underlying material, to a depth of 74 inches, is grayish-brown silt loam.

Included in mapping were small areas where the surface layer is silt loam.

This soil is somewhat poorly drained and slowly permeable. It is easily tilled. The available water capacity is high, and fertility is moderate. Surface runoff is very slow, and the hazard of erosion is slight.

Representative profile of Hockinson loam in a pasture, about 1 mile south and 1 mile east of Battle Ground, 500 feet west and 30 feet north of the southeast corner of sec. 2, T. 3 N., R. 2 E.

Ap-0 to 6 inches, very dark gray (10YR 3/1) loam, gray (10YR 5/1) when dry; few, fine, distinct, dark reddish-brown (5YR 3/4) mottles; moderate, fine, subangular blocky structure and moderate, fine, granular; slightly hard, friable, sticky and slightly plastic ; many fine roots ; strongly acid ; abrupt, smooth boundary. (6 to 9 inches thick)

B1g-6 to 16 inches, dark-gray (10YR 4/1) loam, gray (10YR 6/1) when dry; common, fine, distinct, reddish-brown (5YR 4/3) mottles and many, medium, prominent, yellowish-red (5YR 4/8) mottles; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine, fibrous roots ; many fine and medium pores ; strongly acid ; clear, wavy boundary. (9 to 12 inches thick)

B21tg 16 to 23 inches, dark-gray (10YR 4/1) loam, light brownish gray (10YR 6/2) when dry; common, medium, prominent, yellowish-red (5YR 4/8) mottles; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky ; hard, friable, slightly sticky and slightly plastic ; few, line, fibrous roots ; common fine and medium pores; thin clay films in pores ; few black manganese stains ; medium acid ; clear boundary. (a^5 to 8 inches thick)

B22tg 23 to 30 inches, dark-gray (10YR 4/1) fine sandy loam, light brownish gray (10YR 6/2) when dry; many, medium, prominent, yellowish-red (5YR 4/8) mottles ; weak, coarse, prismatic structure ; very hard, firm, slightly sticky and slightly plastic ; few fine roots; many fine and medium pores ; thin clay films in pores; slightly acid; abrupt, wavy boundary. (6 to 9 inches thick)

B23ta 30 to 41 inches, very dark grayish-crown (10YR 3/2) loam, light brownish gray (10YR 6/2) when dry; many, medium, prominent, yellowish-red (5YR 4/8) mottles ; massive or weak, very coarse, prismatic structure ; very hard, firm, slightly sticky and slightly plastic; no roots; common fine and few medium pores ; thin, patchy clay films on ped surfaces ; few, fine, black (5YR 2/1) manganese segregations ; slightly acid; abrupt, wavy boundary. (8 to 12 inches thick)

C1-41 to 51 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2; when dry; thin lenses of heavy silt loam and fine sandy loam ; common, fine, distinct, yellowish-red (5YR 4/6) mottles; massive ; slightly hard, friable, lightly sticky and slightly plastic ; common fine and medium pores; thin clay films in pores; medium acid; gradual, wavy boundary. (8 to 12 inches thick)

C2-51 to 74 inches, grayish-brown (2.5Y 5/2) silt loam, light olive brown (2.5Y 5/4) when dry; many, medium, prominent, yellowish-red (5YR 4/8) mottles; weak, coarse, prismatic structure; hard, friable, slightly sticky and plastic ; common, medium, tubular pores; thin clay films in pores ; medium acid.

When the soil is moist, the A horizon is very dark gray, very dark grayish brown, or very dark brown. This horizon ranges from strongly acid to slightly acid. In places it lacks mottling. The B horizon ranges from fine sandy loam to silt loam in texture, from gray to grayish brown in color, from strongly acid to slightly acid in reaction, and from hard to very hard in consistence when dry.

Nearly all the acreage is cleared and in cultivation. It is used mainly for hay and pasture. In areas that have been artificially drained, grain, truck crops, and improved hay and pasture are grown. (Capability unit IIIw-1; wildlife site 9 ; not assigned to a woodland suitability group)

Hockinson loam, moderately well drained, 0 to 8 percent slopes (HuB).-This soil is similar to Hockinson loam, 0 to 3 percent slopes, except that the slopes are generally 2 to 4 percent stronger and the depth to the compact, slowly permeable layer is 30 to 36 inches. The color of the upper part of the subsoil is grayish brown, rather than dark gray.

This soil is moderately well drained. The available water capacity is high, and the soil is easily tilled. Surface runoff is slow, and the erosion hazard is slight.

All the acreage is cleared. It is in hay, pasture, and grain. Truck crops and high-producing hay and pasture can be grown in areas that have been artificially drained. (Capability unit Me-4; wildlife site 4; not assigned to a woodland suitability group)

Hockinson-Dollar loams, 0 to 3 percent slopes (HvA).-This complex is made up of approximately 60 percent Hockinson loam, 0 to 3 percent slopes, and 40 percent Dollar loam, 0 to 5 percent slopes. These soils occur on terraces and in low microrelief that creates drainage differences. The Hockinson soil is at a slightly lower elevation and is somewhat poorly drained. The Dollar soil is moderately well drained.

These soils are used mainly for hay, pasture, and grain. Truck crops and high-producing hay and pasture can be grown if these soils are drained. (Capability unit IIIw-1; wildlife site 9 ; not assigned to a woodland suitability group)

Kinney Series

The Kinney series consists of deep, well-drained, gently sloping to very steep soils. These are medium-textured soils that have a moderately fine textured subsoil. They formed in volcanic ash and residuum that weathered from igneous rock. The original vegetation was Douglas-fir, grand fir, hemlock, and western redcedar. The understory plants were vine maple, Oregongrape, salal, ferns, and grasses. The annual precipitation is 60 to 90 inches.

Kinney soils are used principally for timber. Only small areas are cleared and used for pasture because of the remote location, high rainfall, and short growing season.

Kinney silt loam, 30 to 50 percent slopes (KeF).-This soil is on long, steep to very steep mountain slopes and on short, steep to very steep slopes that lead into drainageways. It is the dominant soil in the mountainous eastern part of the county at elevations between 1,600 and 3,000 feet.

In a typical profile the surface layer is very dark grayish brown and about 11 inches thick. It is silt loam in the upper part and gravelly silt loam in the lower part. Below the surface layer is friable gravelly silty clay loam about 26 inches thick. The upper part is dark brown, the middle part is dark yellowish brown, and the lower part is dark brown. The next layer is brown gravelly clay loam about 23 inches thick. The underlying material, to a depth of 72 inches, is weathered igneous bedrock.

This soil is well drained and moderately permeable. Roots penetrate to the bedrock. The available water capacity is high, and fertility is moderate. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe if the surface is left bare.

Representative profile of Kinney silt loan) in woodland, 0.3 mile northwest of Bear Prairie fire gate on Larch Mountain Road, 9 miles northeast of Washougal, NW1/4SW1/4SE1/4 sec. 12, T. 2 N., R. 4 E.

O1-2 inches to 1/2 inch, forest litter from coniferous and deciduous trees and shrubs.

O2-1/2 inch to 0, very dark brown (10YR 2/2) decomposed organic matter, very dark grayish brown (10YR 3/2) when dry.

A11-0 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/21 when dry; moderate, very fine, granular structure ; soft, very friable, nonsticky and nonplastic ; many fine roots ; few, very fine, angular pebbles mixed with some pumice less than half an inch in diameter ; medium acid; clear, wavy boundary. (3 to 7 inches thick)

A12-5 to 11 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, grayish brown (10YR 5/2) when dry; moderate, very fine and fine, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; slightly acid; clear, wavy boundary. (5 to 7 inches thick)

B1-11 to 20 inches, dark-brown (10YR 3/3) gravelly light silty clay loam, brown (10YR 5/3) when dry; weak, very fine and fine, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine and medium pores; few thin cutans (probably pressure faces) on ped surfaces ; medium acid; clear, smooth boundary. (8 to 12 inches thick)

B21-20 to 28 inches, dark yellowish-brown (10YR 3/4) gravelly silty clay loam, yellowish brown (10YR 5/4) when dry; weak, fine and medium, subangular blocky structure ; slightly hard, friable, sticky and plastic; common fine roots; common fine and medium pores; thin, continuous cutans (probably pressure faces) on ped faces ; medium acid ; clear, wavy boundary. (6 to 10 inches thick)

B22-28 to 37 inches, dark-brown (7.5YR 4/4) gravelly silty clay loam, brown (7.5YR 5/4) when dry; weak, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; many fine and medium pores ; thin, continuous cutans (probably pressure faces) on ped surfaces; strongly acid ; clear, wavy boundary. (6 to 12 inches thick)

C1-37 to 60 inches, brown (10YR 4/3) gravelly clay loam, pale brown (10YR 6/3) when dry; massive; hard, firm, sticky and plastic; few fine roots; many fine pores; strongly acid; abrupt, wavy boundary. (13 to 36 inches thick)

C2-60 to 72 inches, deeply weathered and fractured igneous rock.

When the soil is moist, the A horizon ranges from 10YR to 7.5YR in hue and from 2 to 3 in chroma. The solum ranges from 37 to 48 inches in thickness. Gravel and rock fragments of cobblestone size constitute 5 to 35 percent of the soil mass. The texture of the B2 horizon is clay loam, silty clay loam, or light silty clay.

This soil is used for timber and for recreation. (Capability unit VIe-3; woodland suitability group 3rM4; wildlife site 13)

Kinney silt loam, 3 to 15 percent slopes (KeC).-This soil is similar to Kinney silt loam, 30 to 50 percent slopes, except that the surface layer is 1 to 3 inches thicker. Surface runoff is slow to medium, and the erosion hazard is slight to moderate if the surface is left bare.

The main use of this soil is for timber. A few small areas are cleared and used for pasture. (Capability unit IVe-3; woodland suitability group 3oH5; wildlife site 13)

Kinney silt loam, 15 to 30 percent slopes (KeE).-This soil is similar to Kinney silt loam, 30 to 50 percent slopes, except that the surface layer is 1 to 2 inches thicker in places. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe if the surface is left bare.

This soil is suitable for timber and for recreation. (Capability unit VIe-1; woodland suitability group 3oH5; wildlife site 13)

Kinney cobbly silt loam, 30 to 60 percent slopes (KnF).-This soil is similar to Kinney silt loam, 30 to 50 percent slopes, except that the surface layer is cobbly. The available water capacity is moderate.

This soil is suitable for timber and for recreation. (Capability unit VIe-4; woodland suitability group 3rM4; wildlife site 12)

Larchmount Series

The Larchmount series consists of deep, well-drained, mostly steep to very steep, black or very dark brown soils. These are medium-textured soils that are either cobbly or stony or both. They developed in parent material derived from volcanic ash and pumice mixed with weathered igneous rock. They occur on ridgetops and sides of high mountainous areas along the extreme eastern part of Clark County. Larchmount soils are at slightly higher elevations than Olympic and Kinney soils, but are adjacent to them. The native vegetation is predominantly noble fir, vine maple, wild cherry, huckleberry, and bear grass. Douglas-fir and hemlock grow at lower elevations. Most of the original vegetation has been destroyed by fires that have taken place since 1902. The present vegetation is of about the same composition as the native stands. The annual precipitation is more than 100 inches.

Because of the short growing season, high rainfall, and rough topography, these soils are used mostly for timber production.

Larchmount cobbly silt loam, 30 to 75 percent slopes (LaG).-This is the dominant steep and very steep soil at elevations above 2,500 feet in the extreme eastern part of the county. In most places the slopes are between 30 and 50 percent; a few are steeper.

In a typical profile the surface layer is black cobbly silt loam about 23 inches thick. Below the surface layer is firm, dark grayish-brown cobbly heavy silt loam about 11 inches thick. The next layer, to a depth of 48 inches, is dark grayish-brown cobbly heavy silt loam. Below this layer is olive-gray cobbly clay loam about 14 inches thick. The underlying material, at a depth of 62 inches, is fractured granodiorite bedrock. In places the profile is very stony.

This soil is well drained and moderately permeable. The available water capacity is moderately high, and fertility is low. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is bare.

Representative profile of Larchmount cobbly silt loam in open woodland, about 7 miles northeast of Washougal, in State Forest, approximately 200 feet west and 200 feet south of the east quarter corner of sec. 35, T. 3 N., R. 4 E.

A1-0 to 23 inches, black (10YR 2/1) cobbly silt loam, very dark gray (10YR 3/1) when dry; strong, medium and coarse, granular structure ; slightly hard, firm, nonsticky and nonplastic, smeary ; many fine and medium roots ; medium acid; gradual, wavy boundary. (18 to 24 inches thick)

B2-23 to 34 inches, dark grayish-brown (10YR 4/2) cobbly heavy silt loam, light brownish gray (10YR 6/2) when dry ; weak, fine, subangular blocky structure ; hard, firm, slightly sticky and plastic; common fine and medium roots ; many fine pore. ; slightly acid ; clear, smooth boundary. (8 to 14 inches thick)

C1-34 to 48 inches, dark grayish-brown (2.5Y 4/2) cobbly heavy silt loam, light brownish gray (2.5Y 6/2) when dry ; massive ; hard, friable, slightly sticky and plastic ; few fine roots ; many medium and fine tubular pores ; medium acid ; clear, wavy boundary. (10 to 20 inches thick)

IIC2-48 to 62 inches, olive-gray (5Y 5/2) cobbly clay loam, light gray (5Y 7/2) when dry; massive; hard, fri able, sticky and plastic ; no roots; very strongly acid ; irregular, wavy boundary. (12 to 24 inches thick) R-62 inches, fractured granodiorite.

When this soil is moist, the color of the A1 horizon ranges from black to very dark brown. The texture of the B and 0 horizons ranges from silt loam to clay loam. Coarse fragments make up 20 to 50 percent of the solum.

This soil is used for timber and for recreation. At high elevations (above 3,000 feet) there are many pure stands of noble fir of commercial size. (Capability unit VI-4; woodland suitability group 3rM4; wildlife site 13)

Larchmount cobbly silt loam, 15 to 30 percent slopes (LaE).-This soil is similar to Larchmount cobbly silt loam, 30 to 75 percent slopes, except that the surface layer is 1 to 3 inches thicker. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe if the surface is left bare.

This soil is used for timber and for recreation. At the higher elevations, above 3,000 feet, there are pure stands of noble fir and large fields of huckleberry brush. Many ridgetops are barren except for beargrass, which has low grazing value. (Capability unit VIe-1; woodland suitability group 3fM3; wildlife site 13)

Larchmount very stony silt loam, 30 to 75 percent slopes (LcG).-This soil is similar to Larch mount cobbly silt loam, 30 to 75 percent slopes, except that it is very stony. The available water capacity is moderately high.

This soil is used for timber and for recreation. At higher elevations, above 3,000 feet, there are nearly pure stands of noble fir and fields of huckleberry. Many ridgetops are barren except for beargrass. (Capability unit VIe-4; woodland suitability group 3rM4; wildlife site 13)

Lauren Series

The Lauren series consists of deep, somewhat excessively drained, nearly level to gently sloping soils on terraces 50 to 300 feet above the Columbia River. In a few places, on terrace fronts, the soils are steep to very steep. These are very gravelly soils that formed in mixed Columbia River alluvium that contained some volcanic ash. Lauren soils are in the southwestern part of the county, in the vicinity of Mill Plain, Orchards, and Fourth Plain. The original vegetation was Douglas-fir, grand fir, bigleaf maple, vine maple, salal, and ferns. The average annual precipitation is about 48 inches.

Nearly all the acreage is cleared and in cultivation or suburban development. There are a few stands of second-growth Douglas-fir in farm woodlots.

Lauren gravelly loam, 0 to 8 percent slopes (LgB).-This soil occurs on terraces. The slopes are generally less than 4 percent and approach 8 percent only along the terrace breaks.

In a typical profile the surface layer is very dark brown gravelly and very gravelly loam about 20 inches thick. Below the surface layer is friable, dark-brown very gravelly loam about 13 inches thick. The next layer is dark-brown very gravelly coarse sandy loam about 11 inches thick. The underlying material, to a depth of 70 inches, is dark-brown very gravelly loamy coarse sand.

Included in mapping were a few small areas where very gravelly loamy coarse sand is within 30 inches of the surface.

This soil is somewhat excessively drained and easily tilled. Permeability generally is moderately rapid, but it is rapid in the substratum. The available water capacity is moderate. Fertility is moderate. Surface runoff is slow, and the erosion hazard is slight.

Representative profile of Lauren gravelly loam, about 8 miles east of Vancouver, 600 feet north of southeast 15th Street, and 250 feet east of 164th Avenue, SE1/4SE1/4SE1/4 sec. 36, T. 2 N., R. 2 E.

Ap-0 to 6 inches, very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) when dry ; moderate, fine, granular structure ; slightly hard, fri able, slightly sticky and slightly plastic; many fine fibrous roots ; medium acid ; abrupt, smooth boundary. (6 to 8 inches thick)

A1-6 to 20 inches, very dark brown (10YR 2/2) very gravelly loam, dark grayish brown (IoYR 4/2) when dry; moderate, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine fibrous roots; many fine and medium pores; medium acid; gradual, wavy boundary. (8 to 15 inches thick)

B2-20 to 33 inches, dark-brown (10YR 3/3) very gravelly loam, brown (10YR 4/3) when dry; weak, medium, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine fibrous roots ; many very fine, and common medium pores ; slightly acid; clear, wavy boundary. (10 to 15 inches thick)

IIB3-33 to 44 inches, dark-brown (7.5YR 3/2) very gravelly coarse sandy loam, brown (10YR 5/3) when dry ; massive ; slightly hard, very friable, nonsticky and nonplastic ; few fine fibrous roots ; many very fine and medium pores ; slightly acid ; clear, wavy boundary. (5 to 14 inches thick)

IIC-44 to 70 inches, dark-brown (10YR 3/3) very gravelly loamy coarse sand, pale brown (10Y1t 6/3) when dry ; single grain ; loose, nonsticky and nonplastic ; no roots; neutral. (Many feet thick)

The solum ranges from 30 to 48 inches in thickness. Very thin, patchy clay films occur in places on gravel faces and as bridges between sand grains. The lower part of the B horizon ranges from very gravelly loam to very gravelly coarse sandy loam. Less than 25 percent of the coarse fragments are more than 1 inch in diameter.

Most of the acreage is cleared and in cultivation or suburban development. Hay, pasture, and small grain are the principal crops. Red clover and alfalfa are the commonly grown legumes; orchardgrass, tall fescue, and ryegrass are the common grasses. Oats are the main small grain crop (fig. 8). Some truck crops are also grown. (Capability unit IIIe-3 ; woodland. suitability group 4fH2 ; wildlife site 6)

Lauren loam, 0 to 8 percent slopes (LeB).-This soil is similar to Lauren gravelly loam, 0 to 8 percent slopes, except that the surface layer is free of gravel. Surface runoff is slow, and the erosion hazard is slight. Included in mapping were a few small gravelly areas.

Most of this soil is cleared and in cultivation, or is used for suburban development. Hay, pasture, and small grain are the principal crops. Red clover and alfalfa are the commonly grown legumes; orchardgrass, alta fescue, and ryegrass are the common grasses. Oats are the main small grain crop. Some truck crops are also grown. (Capability unit IIIe-3; woodland suitability group 3oM0; wildlife site 6)

Lauren gravelly loam, 8 to 20 percent slopes (LgD).-This soil is along edges of terraces. It is similar to Lauren gravelly loam, 0 to 8 percent slopes, except that the surface layer is 1 to 2 inches thinner. The slopes are short. Surface runoff is medium, and the erosion hazard is moderate.

Hay and pasture are the main crops. Cross-slope or contour tillage helps to control runoff and erosion. The acreage is rapidly being taken over for homesites because it is scenic and has high value as real estate. (Capability unit IVe-1; woodland suitability group 4fH2; wildlife site 6)

Lauren gravelly loam, 20 to 45 percent slopes (LgF).-This soil is similar to Lauren gravelly loam, 0 to 8 percent slopes, except that the surface layer is 1 to 3 inches thinner. The soil is along terrace fronts. The slopes are short. Surface runoff is medium to very rapid, and the erosion hazard is moderate to very severe when the surface is left bare.

This soil is suited to timber ; cleared areas are used for pasture. (Capability unit VIe-5 ; woodland suitability group 4rL5; wildlife site 6)

Lauren very gravelly loam, 0 to 8 percent slopes (LlB).-This soil is similar to Lauren gravelly loam, 0 to 8 percent slopes, except that it is 24 to 30 inches to very gravelly loamy coarse sand, and permeability is very rapid below a depth of 24 inches. Most of the acreage is near Burton, southeast of Orchards. Hay, pasture, and small grain are the principal crops. Red clover and

Figure 8.-Winter oats on Lauren gravelly loam, 0 to 8 percent slopes. This area is near Mill Plain, east of Vancouver.

alfalfa are the commonly grown legumes; orchardgrass, alta fescue, and ryegrass are the common grasses. Oats are the main small grain crop. Some truck crops are also grown. (Capability unit IVe-1; woodland suitability group 4fH2; wildlife site 11)

Lauren gravelly loam, cemented substratum, 3 to 15 percent slopes (LrC).-This soil occurs on ridgetops and bench areas on high terraces. The slopes are smooth. The cementation in this soil is outside the defined range for the Lauren series, but this difference does not alter the usefulness and behavior of the soil.

In a typical profile the surface layer is about 14 inches thick. It is very dark brown gravelly loam in the upper part, and very dark grayish-brown gravelly clay loam in the lower part. Below the surface layer is firm, dark-brown very gravelly clay loam about 21 inches thick. The next layer, to a depth of 60 inches, is dark yellowish-brown very gravelly clay loam. It is weakly cemented.

This soil is moderately well drained. Permeability is moderate in the subsoil and very slow below. The available water capacity is moderate, and fertility is low. Tillage is difficult because of gravel and late-season wetness. Surface runoff is slow to medium, and the erosion hazard is slight to moderate. Sidehill seepage and a high water table are common in winter and spring.

Representative profile of Lauren gravelly loam, cemented substratum, in woodland about 2 miles east of Washougal city limits, 350 feet east of the west quarter comer of sec. 14, T. 1 N., R. 4 E.

A11-0 to 4 inches, very dark brown (10YR 2/2) gravelly loam, grayish brown (10YR 5/2) when dry; moderate, fine and medium, granular structure ; slightly hard, friable, slightly sticky and slightly plastic; many roots; 30 percent gravel; neutral; clear, smooth boundary. (2 to 6 inches thick)

A12-4 to 14 inches, very dark grayish-brown (10YR 3/2) gravelly clay loam, grayish brown (10YR 5/2) when dry ; weak, medium, subangular blocky structure ; hard, firm, sticky and plastic ; common roots ; 40 percent gravel; slightly acid; abrupt, smooth boundary. (8 to 14 inches thick)

B2t-14 to 35 inches, dark-brown (10YR 3/3) very gravelly clay loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure ; hard, firm, sticky and plastic; common roots ; 60 percent gravel thin, patchy clay films on peds and gravel ; slightly acid ; clear, smooth boundary. (10 to 24 inches thick)

C-35 to 60 inches, dark yellowish-brown (10YR 4/4) very gravelly clay loam, yellowish brown (10YR 5/4) when dry; massive ; weakly cemented ; 75 percent gravel ; pebbles are coated with dart reddish-brown, fine-textured material and black stains ; slightly acid. (Many feet thick)

The A1 horizon ranges from 10 to 16 inches in thickness and is 20 to 50 percent gravel. The B horizon is 45 to 70 percent gravel. The depth to the cemented gravelly substratum ranges from 24 to 36 inches. Cementation is strong in places.

The principal use of this soil is for woodland. Hardwoods are suited; Oregon white oak and Oregon ash predominate. Douglas-fir grow only in the better drained areas. The cleared areas support grasses and legumes for hay and pasture; tall fescue and subterranean clover are grown extensively. (Capability unit IVe-3; woodland suitability group 4dL5; wildlife site 10)

Lauren gravelly loam, cemented substratum, 20 to 55 percent slopes (LrF).-This soil is on terraces and terrace fronts. It is similar to Lauren gravelly loam, cemented substratum, 3 to 15 percent slopes, except that the surface layer is generally 1 to 2 inches thinner. Surface runoff is medium to very rapid, and the erosion hazard is moderate to very severe where the surface is left bare.

The soil is used in much the same way as Lauren gravelly loam, cemented substratum, 3 to 15 percent slopes, except that only a little of the acreage is used for pasture or hay. Nearly all the acreage is in woodland. (Capability unit VIe-3 ; woodland suitability group 4rL5 ; wildlife site 10)

McBee Series

The McBee series consists of deep, somewhat poorly drained and moderately well drained, nearly level to gently sloping soils.. These are loamy soils in back-bottom positions along streams and rivers. They formed in alluvium derived from quartzite and basalt. The native vegetation is western redcedar, hemlock, vine maple, red alder, Oregon ash, wild rose, spirea, willow, blackberry, grasses, and sedges. The annual precipitation amounts to about 50 inches.

McBee soils are used for barley, oats, truck crops, hay, and pasture.

McBee silty clay loam, 0 to 3 percent slopes (MeA).-This soil occurs on bottom lands along Salmon Creek, Lockwood Creek, and the Little Washougal River. It is on flats and depressions that are sometimes subject to flooding from adjacent streams.

In a typical profile the surface layer is silty clay loam about 11 inches thick. It is very dark brown in the uppermost part and dark brown in the lower part. The next layer is about 41 inches thick. In sequence from the top, the upper 10 inches is friable, very dark reddish-brown silty clay loam; the next 11 inches is firm, dark-brown silty clay loam ; and the lower 20 inches is firm, grayish-brown and dark yellowish-brown silty clay loam. The underlying material, to a depth of 65 inches, is gray and brown clay.

Included in mapping were some areas where the surface layer is silt loam, and some areas in which mottling begins at a depth of 8 inches. Also included were areas where the surface layer is gravelly, and some where the subsoil is gravelly.

This soil is somewhat poorly drained and moderately permeable. It can be tilled only within a rather narrow range of moisture content. The available water capacity is very high. Fertility is moderate. Surface runoff is ponded or very slow. The erosion hazard is slight, except in areas where the soil is subject to flooding from adjacent streams.

Representative profile of McBee silty clay loam, in a cultivated area 175 feet south of second power pole west of junction of County Roads Nos. 7 and 10, SE1/4NE1/4NW1/4 sec. 7, T. 3 N., R. 3 E.

Ap-0 to 7 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, granular structure ; hard, friable, slightly sticky and plastic ; many roots ; medium acid ; abrupt, smooth boundary. (6 to 9 inches thick)

A1-7 to 11 inches, dark-brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) when dry; few, fine, yellowish-brown mottles (dry) ; moderate, coarse,

granular structure ; hard, friable, slightly sticky and plastic; many roots; many fine pores; medium acid; clear, wavy boundary. (3 to 8 inches thick)

B1-11 to 21 inches, very dark reddish-brown (5YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry ; common, medium, yellowish-brown mottles (dry) ; moderate, medium, subangular blocky structure ; hard, friable, slightly sticky and plastic ; common roots ; many fine pores ; few black stains on pads ; medium acid; gradual, wavy boundary. (8 to 15 inches thick)

B21-21 to 32 inches, dark-brown (7.5YR 4/4) silty clay loam, brown (10YR 5/2) when dry; common, medium, faint, yellowish-brown mottles (dry) ; moderate, medium, subangular blocky structure ; very hard, firm, sticky and very plastic ; few roots ; many fine pores ; black stains on pads ; medium acid; gradual, wavy boundary. (8 to 15 inches thick)

B22g-32 to 52 inches, grayish-brown (10YR 5/1) and dark yellowish-brown (10YR 4/4) silty clay loam, light gray (10YR 7/2) and yellowish brown (10YR 5/4) when dry; moderate, medium, subangular blocky structure; very hard, firm, sticky and very plastic; few roots ; many fine pores ; black stains on pads ; medium acid; clear, smooth boundary. (15 to 24 inches thick)

Cg 52 to 65 inches, gray (10YR 6/1) and brown (7.5YR 4/4) light clay, light gray (10YR 7/1) and reddish yellow (10YR 6/6) when dry; massive very hard, firm, sticky and very plastic ; no roots ; many fine pores ; medium acid.

The A horizon is dark brown, very dark grayish brown, or very dark brown in color.

This soil is in low positions and require, drainage before most cultivated crops can be grown. Red clover, alsike clover, and white clover mixed with ryegrass, orchardgrass, and tall fescue are used for hay and pasture. Oats are also grown for hay in cropping system that includes clover and grass. Some grain and truck crops are also grown. The principal. fertilizer treatment is a yearly application of barnyard manure at a rate of 5 to 6 tons per acre. (Capability unit IIw-1; wildlife site 9 ; not assigned to a woodland suitability group)

McBee silt loam, 0 to 5 percent slopes (McB).-This soil is closely associated with McBee silty clay loam, 0 to 3 percent slopes. It is in slightly higher positions on bottom lands in most places than that soil and has slightly better drainage. It is moderately well drained, and workability is good.

Red clover, alsike clover, and white clover mixed with ryegrass, orchardgrass, and tall fescue are used for hay and pasture. Oats are also grown for hay in a cropping system that includes clover and grass. Some grain and truck crops are also grown.

This soil is somewhat easier to manage and warms up earlier in spring than McBee silty clay loam, 0 to 3 percent slopes. (Capability unit IIw-1; wildlife site 9 ; not assigned to a woodland suitability group)

McBee silt loam, coarse variant, 0 to 3 percent slopes (MlA).-This soil occurs in drainageways and depressions near Hockinson, Brush Prairie, and Manor. In most places the slope is less than 1 percent.

Included in mapping were areas where the lower part of the subsoil contains slabs of bog iron up to 8 inches thick and 18 inches long.

In a typical profile the surface layer is mottled, very dark brown silt loam about 11 inches thick. Below the surface layer is friable, mottled, dark-brown heavy loam about 8 inches thick.

The next layer, to a depth of 44 inches, is mottled, very dark grayish-brown gravelly sandy loam. Below this, to a depth of 62 inches, is dark-brown very gravelly loamy sand.

This soil is somewhat poorly drained. Permeability is moderate. The available water capacity is moderately high, and fertility is moderate. Surface runoff is very slow. Water stands on the surface much of the winter in undrained areas (fig. 9).

This soil can be tilled only within a narrow range of moisture content. Roots penetrate to a depth of about 20 inches ; few penetrate below this depth. There is no erosion hazard.

Representative profile of McBee silt loam, coarse variant, in a cultivated area 2,400 feet south and 1,350 feet east of the northwest corner of SW1/4SE1/4NW1/4 sec. 36, T. 3 N., R. 2 E.

Ap-0 to 5 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; few, fine, distinct, brown (7.5YR 4/4) mottles; moderate, very fine and fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots; slightly acid; abrupt, smooth boundary. (5 to 7 inches thick)

A1-5 to 11 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry ; common, fine, distinct, brown (7.5YR 4/4) mottles; moderate, fine and medium, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; slightly acid ; abrupt, smooth boundary. (4 to 8 inches thick)

B2g-11 to 19 inches, dark-brown (10YR 3/3) heavy loam, brown (10YR 5/3) when dry; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles (moist) ; weak, medium, subangular blocky structure ; hard, friable, slightly sticky and slightly plastic ; few fine roots ; common fine pores ; neutral ; gradual, smooth boundary. (6 to 12 inches thick)

IIC1-19 to 44 inches, very dark grayish-brown (10YR 3/2) gravelly fine sandy loam, brown (10YR 5/3) when dry ; common, medium, faint, dark-brown mottles ; massive; very hard (weakly cemented with iron),

Figure 9.-A ponded area of McBee silt loam, coarse variant, 0 to 3 percent slopes. The surrounding soil is Dollar loam. This area is near Brush Prairie.

firm, slightly sticky and nonplastic ; few fine roots ; many fine pores; neutral; gradual, smooth boundary. (16 to 30 inches thick)

IIC2-44 to 62 inches, dark-brown (10YR 3/3) very gravelly loamy sand, yellowish brown (10YR 5/4) when dry; massive ; loose, nonsticky and nor plastic ; no roots ; highly stained with iron and manganese ; neutral.

The A horizon ranges from black to very dark brown in color when moist. The B horizon ranges from dark brown to very dark grayish brown when moist. Mottles in the A1 and B2g horizons range from prominent to distinct and from fine to medium in size.

Only native pasture composed of ryegrass, velvetgrass, sedges, and various water-tolerant, weedy plants can be grown in undrained areas. If this soil is drained, improved hay and pasture composed of fescue, orchardgrass, foxtail, birdsfoot trefoil, and red and white clovers can be grown. Oats and barley are grown in a cropping system with hay and pasture. (Capability unit IIIw-1; wildlife site 9 ; not assigned to a woodland suitability group)

Minniece Series

The Minniece series consists of deep, poorly drained, nearly level to moderately steep soils. These soils have a clayey subsoil and are underlain by basalt bedrock at a depth of 40 inches or more. They formed in upland basins and drainageways from material of basic igneous origin. 'The original vegetation was Oregon white oak, willow, Oregon ash, hardhack, snowberry, sedges, and ferns. The annual precipitation is 55 to 90 inches.

Minniece soils are used for grain, hay, and pasture.

Minniece silty clay loam, 0 to 3 percent slopes (MnA).-This soil is in broad upland basins and in upland drainageways associated with Olympic soils. Most of the acreage is in the north-central part of the county.

In a typical profile the surface layer is very dark gray in color and about 10 inches in thickness. In sequence from the top, the upper 4 inches is silty clay loam, and the lower 6 inches is silty clay. The subsurface layer is mottled very dark gray silty clay about 7 inches thick. Below the subsurface layer is clay about 25 inches thick. In sequence from the top, the upper 10 inches is firm, mottled, and olive gray; the next 9 inches is firm, mottled, and gray ; and the lower 6 inches is very firm, mottled, and gray. The next layer is mottled, dark grayish-brown clay about 6 inches thick. The underlying material, at a depth of 48 inches, is basalt bedrock.

Included in mapping were small areas where the surface layer is silt loam and clay loam.

This soil is poorly drained and very slowly permeable. Roots penetrate to a depth of about 17 inches; only a few go to greater depths. The available water capacity is low, and fertility is moderately low. Tillage is a problem because the soil can be tilled only within a narrow range of moisture content. Runoff is very slow, and the soil stays wet late into spring unless it is drained. There is no erosion hazard.

Representative profile of Minniece silty clay loam in a cultivated area, about 3 miles south of Fargher Lake, 1/8 mile north of south section line, SE1/4SW1/4 sec. 12, T. 4 N., R. 2 E.

Ap-0 to 4 inches, very dark gray (5YR 3/1) silty clay loam, dark gray (10YR 4/1) when dry ; strong, fine and medium, subangular blocky structure; very hard, firm, sticky and plastic ; many fine and medium roots; slightly acid; abrupt, smooth boundary. (4 to 5 inches thick)

A1-4 to 10 inches, very dark gray (5YR 3/1) silty clay, dark gray (10YR 4/1) when dry; strong, very fine and fine, subangular blocky structure ; very hard, firm, very sticky and very plastic ; many fine and medium roots ; many very fine pores ; slightly acid ; clear, smooth boundary. (5 to 7 inches thick)

A3-10 to 17 inches, very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) when dry; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; strong, fine, subangular blocky structure; very hard, firm, very sticky and very plastic ; many fine and medium roots ; many very fine pores; slightly acid ; clear, wavy boundary. (5 to 8 inches thick)

B21g-17 to 27 inches, olive-gray (5Y 5/2) clay, light olive gray (5Y 6/2) when dry; many, fine, prominent, dark-brown (7.5YR 4/4) mottles; strong, medium, subangular blocky structure ; extremely hard, firm, very sticky and very plastic ; few fine fibrous roots ; many very fine pores ; slightly acid ; gradual, smooth boundary. (7 to 12 inches thick)

B22g 27 to 36 inches, gray (5Y 5/1) clay, light gray (5Y 6/1) when dry; many, fine, prominent, yellowish-red (5YR 4/6) mottles; strong, medium, prismatic structure ; extremely hard, firm, very sticky and very plastic ; few very fine fibrous roots ; few very fine pores ; few, medium, distinct, black (5YR 2/1) manganese stains ; slightly acid ; clear, smooth boundary. (8 to 10 inches thick)

B3g-36 to 42 inches, gray (5Y 5/1) clay, light gray (5Y 6/1) when dry; many, fine, prominent, dark-brown (7.5YR 4/4) mottles ; massive ; extremely hard, very firm, very sticky and *very* plastic ; no roots ; few very fine pores; mildly alkaline; clear, smooth boundary. (4 to 8 inches thick)

C-42 to 48 inches, dark grayish-brown (10YR 4/2) clay, light gray (10YR 6/2) when dry; common, medium, prominent, strong-brown (7.5YR 5/6) mottles and common, medium, distinct, light-gray (5Y 7/2) mottles ; massive ; extremely hard, very firm, very sticky and very plastic ; mildly alkaline ; abrupt, wavy boundary. (5 to 6 inches thick)

R-48 inches, basalt bedrock.

Basalt and andesite gravel, stones, and cobblestones make up as much as 10 percent of the solum. The depth to bedrock ranges from 40 to 72 inches.

Subsurface drainage generally is not feasible, but this soil is suited to permanent pasture. In places land smoothing or shaping to form shallow, open drainageways has been used to carry off surface water. (Capability unit Vw-1; wildlife site 9 ; not assigned to a woodland suitability group)

Minniece silty clay loam, 3 to 20 percent slopes (MnD).-Much of this soil is very wet. Seep spots are numerous. Surface runoff is slow to medium, and the erosion hazard is slight to moderate.

The areas of this soil are generally too small to be managed separately from the surrounding Olympic or Hesson soils. Where cleared, the soil is suited to perennial pasture. Wetness and the slope severely limit farming use. (Capability unit VIw-1; wildlife site 9; not assigned to a woodland suitability group)

Minniece silt loam, thin solum variant, 0 to 3 percent slopes (MoA).-This soil is in drainageways and concave depressions in the Chelatchie Valley.

In a typical profile the surface layer is black silt loam about 10 inches thick. The subsurface layer is mottled, gray silt loam about 2 inches thick. Below the subsurface layer is firm clay about 10 inches thick. It is mottled very dark grayish brown in the upper part and mottled dark grayish brown in the lower part. The next layer, to a depth of 60 inches, is weakly cemented. It is very firm, mottled, dark grayish-brown gravelly loam in the upper part, and very firm, dark-brown very gravelly clay loam in the lower part.

Included in mapping were small areas where the substratum is compact, weakly cemented loamy fine sand. Gravel makes up less than 25 percent of the substratum in these places.

This soil is poorly drained and very slowly permeable. Roots penetrate only to the cemented substratum. The available water capacity and fertility are low. Surface runoff is very slow; the surface is ponded during most of the latter part of winter and in spring. Tillage is a problem because of the poor drainage. If drainage is satisfactory, seedbeds can be prepared. There is no erosion hazard.

Representative profile of Minniece silt loam, thin solum variant, in a pasture north of State Highway 1-S and 20 yards west of Potsdam Road, SE1/4SE1/4SW1/4 sec. 11, T. 5 N., R. 3 E.

Ap-0 to 6 inches, black (10YR 2/1) silt loan, dark gray (10YR 4/1) when dry; weak, very fire, granular structure ; slightly hard, friable, slightl7 sticky and slightly plastic; many very fine and fin? roots; few fine pores ; slightly acid ; clear, smooth boundary. (5 to 8 inches thick)

A1-6 to 10 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) when dry; moderate, very fine, granular structure ; slightly hard, friable, nonsticky and slightly plastic ; many very fine and fine roots ; few fine pores; slightly acid; clear, wavy boundary. (3 to 5 inches thick)

A2-10 to 11 1/2 inches, gray (10YR 5/1) silt loam, light gray (10YR 7/1) when dry; few, fine, distinct, brownishyellow (10YR 6/6, dry) mottles; weak, very thin, platy structure to massive; slightly hard, friable, nonsticky and slightly plastic ; slightly acid ; abrupt, irregular boundary. (1/2 inch to 2 inches thick)

B21tg-11 1/2 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay, light brownish gray (10YR 6/2) when dry; common, medium, prominent, dark reddish-brown (5YR 3/4) mottles; moderate, medium, prismatic structure ; hard, firm, sticky and plastic ; few fine roots ; common very fine and fine pores ; medium, continuous clay films on peds and in pores; slightly acid ; clear, wavy boundary. (2 to 6 inches thick)

B22tg-15 to 22 inches, dark grayish-brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) when dry; common, medium, prominent, dark-brown (7.5YR 5/2, dry) mottles ; moderate, medium, prismatic structure and moderate, medium, angular blocky ; extremely hard, firm, sticky and plastic ; very few fine roots ; common very fine pores ; medium, continuous clay films on ped surfaces and in pores ; slightly acid ; abrupt, smooth boundary. (6 to 8 inches thick)

C1s-22 to 26 inches, dark grayish-brown (10YR 4/2) gravelly loam, pale brown (10YR 6/3) when dry; common, medium, prominent, dark-brown 7.5YR 4/4) mottles ; massive ; weakly cemented with silica and iron ; very hard, very firm, slightly sticky and nonplastic ; no roots ; few very fine pores ; 35 to 50 percent rounded gravel, pebbles are 1/2 inches to 3 inches in diameter ; a few cobblestones ; slightly acid; abrupt, wavy boundary. (2 to 4 inches thick)

C2s-26 to 60 inches, dark-brown (10YR 4/3) very gravelly clay loam, very pale brown (10YR 7/3) when dry; massive; weakly cemented ; very hard, very firm, slightly sticky and slightly plastic ; few very fine pores; more than 50 percent gravel and cobblestones ; medium acid.

The A horizon ranges from black to very dark brown in color. When the soil is moist, the B horizon ranges from 10YR to 7.5YR in hue and from 2 to 3 in chroma.

Only native grasses, sedges, and weedy plants can be grown in undrained areas. In drained areas grain, grasses, and such legumes as tall fescue, meadow foxtail, perennial ryegrass, birdsfoot trefoil, big trefoil, and red and white clovers are grown. (Capability unit IVw-1; wildlife site 9 ; not assigned to a woodland suitability group)

Mossyrock Series

The Mossyrock series consists of deep, black, well drained and moderately well drained soils that are mostly nearly level to gently undulating. These are medium-textured soils that formed in old alluvium derived from volcanic ash, pumice, and basic igneous rock. All the acreage is in the Chelatchie Valley on low terraces of the valley floor, next to the poorly drained Minniece, thin solum variant, soils. The original vegetation was mainly grasses, bracken fern, red alder, some vine maple, and scattered stands of Douglas-fir. The annual precipitation is 85 to 95 inches.

These soils are used mostly for hay, pasture, and small grain in conjunction with beef and dairy farms.

Mossyrock silt loam, 0 to 5 percent slopes (MsB).-This is the dominant soil on the floor of the Chelatchie Valley.

In a typical profile the surface layer is black silt loam about 23 inches thick. Below the surface layer is friable, mottled, dark yellowish-brown silt loam about 37 inches thick. The next layer, to a depth of 74 inches, is mottled, brown loam.

Included in mapping were small areas where the surface layer is loam and small areas where gravel makes up as much as 10 percent of the subsoil.

This soil is moderately well drained and moderately permeable. It is easily tilled. The available water capacity is very high. Fertility is low. Surface runoff is slow, and the hazard of water erosion is slight.

Representative profile of Mossyrock silt loam, about 2 miles northeast of Amboy, 700 feet south and 50 feet east of north quarter corner of sec. 15, T. 5 N., R. 3 E.

Ap-0 to 7 inches, black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) when dry ; moderate, very fine, granular structure ; soft, very friable, nonsticky, slightly plastic, and smeary ; many roots ; slightly acid; abrupt, smooth boundary. (6 to 8 inches thick)

A11-7 to 16 inches, black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, very fine, granular structure ; soft, very friable, nonsticky, slightly plastic, and smeary ; many roots ; common very fine pores ; slightly acid ; clear, wavy boundary. (6 to 10 inches thick)

A12-16 to 23 inches, black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, very fine, subangular blocky structure ; soft, very friable, slightly sticky, slightly plastic, and smeary ; few roots ; many very fine and fine pores ; slightly acid; gradual, wavy boundary. (3 to 9 inches thick)

B2-23 to 60 inches, dark yellowish-brown (10YR 4/4) silt loam, light yellowish brown (10Y71 6/4) when dry; common, medium, faint, strong-brown (7.5YR 5/6) mottles ; weak, coarse, prismatic ,structure breaking to weak, medium and coarse, subangular blocky ; slightly hard, friable, slightly sticky, slightly plastic, and smeary ; few roots ; many very fine and fine pores ; few fine pumice grains ; neutral; clear, wavy boundary. (24 to 48 inches thick)

C-60 to 74 inches, brown (10YR 4/3) loam, light brownish gray (10YR 6/2) when dry; few, medium, distinct, dark reddish-brown (5YR 3/4) and grayish-brown (2.5YR 5/2) mottles ; massive ; hard, firm, sticky, plastic, and smeary ; few roots ; few very fine pores ; thin, discontinuous, dark yellowish-brown (10YR 4/4) clay films in pores; slightly acid.

Faint mottles occur at depths ranging from 22 to 30 inches.

This soil is used mainly for grasses, legumes, and small grain (fig. 10). It can be used for Douglas-fir and red alder. Some potatoes are also grown. (Capability unit IIIe-2 ; woodland suitability group 3oM3; wildlife site 5)

Newberg Series

The Newberg series consists of deep, well-drained, nearly level to gently sloping soils on flood plains. These are loamy soils that developed mainly in recent alluvium derived from basic igneous parent material. The native plant cover is mixed deciduous and coniferous vegetation. The average annual precipitation ranges from 38 to 60 inches.

Newberg soils are used for grain, truck crops, woodland, pasture, and hay.

Newberg silt loam, 0 to 3 percent slopes (NbA).-This soil occurs mainly along the Columbia River.

In a typical profile the surface layer is very dark grayish brown and about 12 inches thick. It is silt loam in the upper part and fine sandy loam in the lower part. Below the surface layer is very friable, brown fine sandy loam about 28 inches thick. The next layer is dark grayish-brown sandy loam about 12 inches thick. The underlying material, to a depth of 72 inches, is light brownish-gray sand.

Included in mapping were small areas where the surface layer is sandy loam or sand, and areas where sand occurs at a depth of less than 40 inches.

This soil is well drained. It is easily tilled. Permeability is moderately rapid. The available water capacity is high, and fertility is high. Surface runoff is very slow, and there is no erosion hazard.

Representative profile of Newberg silt loam in a cultivated area, about 1,500 feet south and 500 feet east of the northwest corner of sec. 20 T. 2 N., R. 1 W.

Ap-0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry ; moderate, medium and coarse, granular structure ; slightly hard, very friable, slightly sticky and slightly plastic ; many roots ; medium acid ; abrupt, smooth boundary. (6 to 9 inches thick)

A1-7 to 12 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, brown (10YR 4/3) when dry ; moderate, medium and coarse, granular structure ; slightly hard, very friable, nonsticky and nonplastic ; many fine roots ; many fine and medium pores ; slightly acid ; clear, smooth boundary. (4 to 8 inches thick)

Figure 10.-Hay on Mossyrock wilt loam, 0 to 5 percent slopes, foreground, in the Chelatchie Valley. Cinebar silt loam on Tumtum Mountain, middle ground and surrounding area.

B2-12 to 40 inches, brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) when dry; weak-, fine, subangular blocky structure ; slightly hard, very friable, nonsticky and nonplastic ; common fine roots; many fine and medium pores; neutral ; abrupt, smooth boundary. (20 to 32 inches thick)

C1-40 to 52 inches, dark grayish-brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) when dry; weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic ; few fine roots; many, fine and medium, tubular pores ; neutral; abrupt, smooth boundary. (10 to 20 inches thick)

C2-52 to 72 inches, light brownish-gray (2.5Y 6/2) sand, dark grayish brown (2.5Y 4/2) when dry; single grain; loose, nonsticky and nonplastic; few fine roots; neutral.

The A horizon ranges from silt loam to fine sandy loam in texture.

Most of the acreage is protected from flooding by dikes. It is used for and is well suited to truck crops, row crops, hay, and pasture. Areas not protected by dikes are subject to flooding, erosion, and deposition (fig. 11). (Capability unit I-1; wildlife site 2; not assigned to a woodland suitability group)

Newberg silt loam, 3 to 8 percent slopes (NbB).-This soil is on side slopes of natural levees on bottom lands along the Columbia River. The slopes are short and slightly convex or undulating. The soil is similar to Newberg silt loam, 0 to 3 percent slopes, except that surface runoff is slow, and the erosion hazard is slight.

Where it is protected by dikes, this soil is well suited to truck crops, row crops, and hay and pasture. Cross-slope farming is practiced to check surface runoff and control erosion. (Capability unit IIe-2 ; wildlife site 2 ; not assigned to a woodland suitability group)

Odne Series

The Odne series consists of deep, poorly drained, mostly nearly level soils. These are loamy soils underlain by a compact subsoil at a depth of 16 to 24 inches. They formed in drainageways and depressions on terraces adjoining Gee soils in the northwestern part of Clark County. They developed in old Columbia River sediments of mixed origin. The original vegetation consisted of water-tolerant trees, grasses, sedges, and shrubs. The annual precipitation is 40 to 60 inches.

Odne soils are used mainly for pasture, hay, and small grain.

Odne silt loam, 0 to 5 percent slopes (OdB).-This soil is generally in concave areas in drainageways or depressions within areas of Gee soils. In most places the slope is 1 to 2 percent; some side slopes that lead into the drainageways are steeper.

In a typical profile the surface layer is about 10 inches thick. It is mottled, dark-gray heavy silt loam in the upper part, and mottled, dark-gray silty clay loam in the lower part. The subsurface layer is firm, mottled, gray silt loam about 9 inches thick. The next 8 inches is very firm, mottled, dark-gray silty clay loam that overlies 6 inches of firm, mottled, dark-gray clay loam. Below this, to a depth of 50 inches, is mottled dark-gray loam.

This soil is poorly drained and very slowly permeable. The compact subsoil limits effective root penetration to a depth of less than 30 inches. The available water capacity and fertility are moderate. Tillage is easy, but spring wetness delays operation of equipment. Surface runoff is very slow to slow, and the hazard of erosion is slight. A high water table is common in winter.

Figure 11.-Deposition of sand on Newberg silt loam, 0 to 3 percent slopes, middle ground, that resulted from flooding by the Columbia River. The sandy soil along the river in the right foreground is an area of Riverwash. This area is 3 miles downriver from Vancouver.

Representative profile of Odne silt loam, in a pasture on Archambault Road, approximately 700 feet east and 125 feet south of the northwest corner of sec. 23, T. 4 N., R. 1 E.

Ap-0 to 5 inches, dark-gray (10YR 4/1) heavy silt loam, grayish brown (10YR 5/2) when dry; few, fine, distinct, dark reddish-brown (5YR 3/4) mottles ; moderate, fine, granular structure; slightly hard, friable, sticky and plastic ; many fine fibrous roots ; common very fine shotlike concretions of dark reddish brown (5YR 3/3) ; strongly acid; abrupt, smooth boundary. (4 to 6 inches thick)

A1-5 to 10 inches, dark-gray (10YR 4/1) silty clay loam, light brownish gray (10YR 6/2) when dry; many, medium, prominent, dark reddish-brown (5YR 2/2) mottles; moderate, very fine, subangular blocky structure ; hard, friable, sticky and plastic ; many fine fibrous roots ; many fine pores ; common, very fine, dark reddish-brown (5YR 3/3) shotlike concretions; very strongly acid; clear, wavy boundary. (4 to 6 inches thick)

A2-10 to 19 inches, gray (5Y 5/1) silt l)am, light gray (5Y 6/1) when dry; many, fine, prominent, yellowishred (5YR 4/8) mottles; weak, very fine, subangular blocky structure ; very hard, firm, sticky and plastic ; common, fine, fibrous roots ; many line pores ; thin, nearly continuous clay films in pores and on ped surfaces; black (N 2/0) manganese segregations 2 to 15 millimeters in size ; strongly acid ; clear, wavy boundary. (8 to 12 inches thick)

B21tg 19 to 27 inches, dark-gray (5Y 4/1) silty clay loam, light gray (5Y 6/1) when dry; common, medium, distinct, reddish-brown (5YR 4/4) mottles ; moderate, medium, prismatic structure breaking to moderate, fine, angular blocky ; extremely hard, very firm, very sticky and very plastic ; few fine fibrous roots ; common, fine, tubular and interstitial pores; common black (N 2/0) manganese segregations 2 to 15 millimeters in size; thick, continuous clay films on ped surfaces and in pores ; strongly acid ; clear, wavy boundary. (8 to 10 inches thick)

B22tg-27 to 33 inches, dark-gray (5Y 4/1) clay loam, light olive gray (5Y 6/2) when dry ; common, fine, distinct, dark reddish-brown (5YR 3/4) mottles; moderate, medium, prismatic structure breaking to moderate, medium, angular blocky ; extremely lard, firm, sticky and plastic ; few fine roots in upper part of the horizon and no roots in lower part; few fine pores; few, fine, black (N 2/0) manganese segregations ; moderate, continuous clay films in pores and on horizontal and vertical surfaces; common fine mica flakes ; strongly acid; gradual, wavy boundary. (5 to 9 inches thick)

B3g-33 to 50 inches, dark-gray (5Y 4/1) loam, light olive gray (5Y 6/2) when dry; moderate, medium, distinct mottles, dark grayish brown (10YR 4/2) when dry; moderate, medium, prismatic structure; extremely hard, very firm, slightly sticky and slightly plastic ; common, medium, tubular pores; continuous, moderately thick clay films in pores ; tongues of gray (5Y 5/1) silty clay loam, light gray (5Y 7/1) when dry, 1/2 to 3/4 inch thick, extend downward in fractures ; slightly acid.

The A horizon ranges from 1 to 2 in chroma, and from silt loam to silty clay loam in texture. The texture of the B2tg horizon in most places is silty clay loam, but in other places it is heavy silt loam or clay loam. The B2tg horizon ranges from 10YR to 5Y in hue, from 4 to 5 in value, and from 1 to 2 in chroma. Clay films in the B2tg horizon range from moderate, continuous to thick, continuous on peds and in pores.

Water-tolerant grasses and legumes are used for hay and pasture. If artificial drainage is installed, small grains and snore productive grasses and legumes can be grown. (Capability unit IVw-1; woodland suitability group 2dL3; wildlife site 9)

Olequa Series

The Olequa series consists of deep, well-drained, gently undulating to very steep soils on terraces above the flood plains. These are loamy soils that formed in parent material largely of basic igneous origin. Along the Lewis River and in the Battle Ground areas, the soils are predominantly derived from basic igneous material. In the Little Washougal River area, they contain some quartzite but are otherwise much the same as in the other areas. The original vegetation was chiefly Douglas-fir, redcedar, and grand fir. The understory is oceanspray, hazel, vine maple, salal, and Oregongrape. Nearly all of the original stands have been logged, and the second growth is composed of Douglas-fir, red alder, redcedar, and grand fir. Many areas are dominated by red alder. The annual precipitation is 50 to 65 inches.

Most of the nearly level to sloping areas are used for crops. Hay and pasture are the principal crops, but there are small acreages of nuts, fruits, and row crops.

Olequa silt loam, 3 to 20 percent slopes (OeD).-This is the dominant soil on terraces 50 to 150 feet above the level of the North Fork of the Lewis and Washougal Rivers.

In a typical profile the surface layer is very dark grayish-brown silt loam about 10 inches thick. The next layer is 68 inches thick. In sequence from the top, the upper 13 inches is friable, dark-brown silt loam, and the next 55 inches is firm, mottled, brown silty clay loam. The underlying material, to a depth of 90 inches, is mottled, dark-brown heavy silt loam.

Included in mapping were small areas of a poorly drained soil that occurs above the level of the North Fork of the Lewis and the Washougal Rivers. Also included were stony areas north of Battle Ground.

This soil is well drained and moderately slowly permeable. It is easily tilled. Fertility is moderately high, and the available water capacity is very high. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

Representative profile of Olequa silt loam in a pasture about 5 miles northeast of Woodland, 100 feet west of field gate, NE1/4SE1/4 sec. 10, T. 5 N., R.1 E.

Ap-0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, very fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many medium and fine roots ; slightly acid; abrupt, smooth boundary. (5 to 6 inches thick)

A1-6 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, very fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots many fine and medium pores ; slightly acid; clear, smooth boundary. (4 to 9 inches thick)

B1-10 to 17 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry ; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; many fine roots; many fine and medium pores ; slightly acid ; abrupt, wavy boundary. (6 to 8 inches thick)

B21t-17 to 23 inches, dark-brown (10YR 3/3) heavy silt loam, brown (10YR 5/3) when dry; moderate, fine, subangular blocky structure; bard, friable, slightly sticky and plastic ; many fine roots ; many fine and medium pores; thin clay films in pores ; slightly acid; clear, wavy boundary. (5 to 7 inches thick)

B22t-23 to 40 inches, brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) when dry; few, faint, dark brown (7.5YR 4/4) mottles at a depth below 34 inches ; moderate, fine, subangular blocky structure ; hard, firm, sticky and plastic; few fine roots; many fine and medium pores; thin, continuous clay films on ped faces; medium acid; clear, wavy boundary. (16 to 19 inches thick)

B23t-40 to 65 inches, brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) when dry; common, medium, faint, dark-brown (10YR 3/3) mottles; strong, medium, angular blocky structure; hard, firm, sticky and plastic ; few fine fibrous roots ; many fine pores ; thin, continuous clay films on ped surfaces ; common, medium, black manganese stains medium acid; clear, wavy boundary. (24 to 27 inches thick)

B3t--65 to 78 inches, brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) when dry; common, medium, distinct, dark reddish-brown mottles; grayish-brown silt coatings on peds; moderate, medium, angular blocky structure; hard, firm, slightly sticky and plastic; no roots; common, fine, tubular pores; thin, patchy clay films on ped surfaces ; very strongly acid ; clear, wavy boundary. (11 to 15 inches thick)

C-78 to 90 inches, dark-brown (10YR 4/3) heavy silt loam, pale brown (10YR 6/3) when dry; massive; hard, firm, slightly sticky and slightly plastic : many, fine, tubular pores ; thin clay films in pores ; few, medium, prominent, black (5YR 2/1) manganese stains; medium acid.

The A1 horizon ranges from very dark grayish brown to very dark brown in color. In places this horizon contains few to many, fine and very fine concretions. In winter, in nearly level areas, a perched water table is common at a depth below 36 inches. In the B horizon, the hue ranges from 7.5YR to 10YR. In places the B horizon has characteristics of brittleness.

Most of this soil is cleared and in cultivation. Long-lived hay and pasture, composed of legumes and grasses, are the principal crops. Fertilization and careful management are needed to maintain good pasture and hay. A small acreage is used for strawberries and filberts. (Capability unit IIIe-l; woodland suitability group 2dL3; wildlife site 3)

Olequa silt loam, 20 to 30 percent slopes (OeE).-This soil is similar to Olequa silt loam, 3 to 20 percent slopes, except that the surface layer is commonly 1 t o 3 inches thinner. Surface runoff is medium to rapid. The erosion hazard is moderate to severe when the surf ice is left bare.

This soil is generally too steep for cultivation, but it is suited to timber. Douglas-fir is well suite I. Cleared areas are commonly used for pasture. (Capability unit IVe-4 ; woodland suitability group 2dL3 ; wildlife site 3)

Olequa silt loam, 30 to 60 percent slopes (OeF).-This soil is similar to Olequa silt loam, 3 to 20 percent slopes, except that the surface layer is 2 to 3 inches thinner. Surface runoff is rapid to very rapid, and the erosion hazard is moderate to severe if the surface is left bare.

This soil is too steep for cultivation, but it is suited to timber. (Capability unit VIe-3; woodland suitability group 2rL5; wildlife site 3)

Olequa silty clay loam, heavy variant, 3 to 20 percent slopes (OhD).-This soil is on ridgetops and benches. In most places the slopes are long and smooth, and the slope ranges from 3 to 8 percent.

In a typical profile the surface layer is dark reddish-brown silty clay loam about 11 inches thick. The next layer is 60 inches thick. In sequence from the top, the upper 9 inches is friable, dark reddish-brown silty clay loam ; the next 12 inches is firm, mottled, brown silty clay loam; the next 12 inches is firm, mottled, grayishbrown silty clay; the next 11 inches is firm, mottled, light brownish-gray clay; and the lower 16 inches is firm, mottled gray clay. The underlying material, to a depth of 82 inches, is light olive-gray clay.

Included in mapping were small areas where the surface layer is silt loam.

This soil is somewhat poorly drained and easily tilled. Permeability is moderately slow above the clay horizons and very slow in the clay horizons. There are very few roots in the clay. The available water capacity is high, and fertility is moderate. Surface runoff is slow to medium, and the erosion hazard is slight to moderate. A high water table is common in winter.

Representative profile of Olequa silty clay loam, heavy variant, in a logged area about 3/8 mile north of Bill Harrison Road No. 3 in NW1/4SE1/4 sec. 4, T. 4 N., R. 2 E.

A11-0 to 5 inches, dark reddish-brown (5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) when dry; moderate, fine, granular structure ; slightly hard, friable, sticky and plastic; many, fine and medium, fibrous roots ; medium acid; clear, smooth boundary. (4 to 6 inches thick)

A12-5 to 11 inches, dark reddish-brown (5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) when dry; strong, fine, granular structure; slightly hard, friable, sticky and plastic ; many fine roots ; medium acid ; abrupt, wavy boundary. (6 to 7 inches thick)

B1t-11 to 20 inches, dark reddish-brown (5YR 3/4) silty clay loam, brown (7.5YR 5/4) when dry ; moderate, fine, subangular blocky structure; slightly hard, friable, sticky and plastic ; common, fine and medium, fibrous roots ; many, very fine, tubular pores ; thin, nearly continuous clay films on ped surfaces ; strongly acid; clear, wavy boundary. (10 to 14 inches thick)

B21t-20 to 32 inches, brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) when dry ; common, coarse, prominent, dark-brown (7.5YR 4/4) mottles; strong, fine, subangular blocky structure ; hard, firm, sticky and plastic; common, fine and medium, fibrous roots; many, very fine and medium, tubular pores; moderately thick, continuous clay films ; common, fine, prominent, black (N 2/0) manganese segregations; strongly acid; clear, wavy boundary. (10 to 13 inches thick)

B22tb 32 to 44 inches, grayish-brown (2.5YR 5/2) silty *clay,* light gray (2.5Y 7/2) when dry; many, coarse, prominent, dark-brown (7.5YR 4/4) mottles; moderate, medium, prismatic structure breaking to moderate, medium, angular blocky ; hard, firm, very sticky and very plastic; few, fine, fibrous roots on ped surfaces ; many, very fine, tubular pores ; thick, continuous clay films on ped surfaces; few, coarse, prominent, black (N 2/0) manganese segregations; slightly acid; clear, wavy boundary. (10 to 13 inches thick)

B23g-44 to 55 inches, light brownish-gray (2.5Y 6/2) clay, light gray (2.5Y 7/2) when dry ; many, coarse, prominent, dark-brown (7.5YR 4/4) mottles; strong, fine and medium, angular blocky structure ; extremely

hard, firm, very sticky and very plastic ; few fine roots on ped surfaces ; few, very fine, tubular pores ; medium acid; clear, smooth boundary. (10 to 12 inches thick)

B24g-55 to 71 inches, gray (5Y 5/1) clay, gray (5Y 6/1) when dry; many, coarse, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure breaking to moderate, very fine, angular blocky ; extremely hard, firm, very sticky and very plastic ; no roots ; few, very fine, tubular pores ; medium acid; gradual, smooth boundary. (18 to 22 inches thick)

IIC-71 to 82 inches, light olive-gray (5Y 6/2) clay, light gray (5Y 7/2) when dry; massive; extremely hard, firm, very sticky and very plastic ; strongly acid.

The A and B1 horizons range from 5YR to 10YR in hue, depending on colors of the associated soils, which are generally of the Salkum, Gee, or Olympic series. Where Olequa soils are associated with Hesson, Salkum, or Olympic soils, the hues are 5YR to 7.5YR; where associated with Gee soils, the hue is 10YR. A few pebbles and 2obblestones occur throughout the profile to a depth of 55 inches.

Mixtures of red clover, alsike clover, orchardgrass, and ryegrass are the principal hay and pasture crops. Some row crops, such as strawberries, cucumbers, and corn, can be grown. They should be planted and cultivated across the slope. (Capability unit IIIe-1; woodland suitability group 3dL6; wildlife site 7)

Olequa silty clay loam, heavy variant, 20 to 45 percent slopes (OhF).-This soil is on side slopes along streams and drainageways. It is similar to Olequa silty clay loam, heavy variant, 3 to 20 percent slopes, except that it is moderately well drained and the surface layer is 2 to 3 inches thinner. Surface runoff is medium to very rapid, and the erosion hazard is moderate to very severe where the surface is left bare.

This soil is suited to timber. (Capability unit VIe-3; woodland suitability group 3rL6; wildlife site 7)

Olympic Series

The Olympic series consists of well-drained, gently sloping to very steep soils underlain by basalt bedrock at a depth of 40 inches or more. These are moderately fine textured soils that formed on mountainous foot slopes in weathered igneous lava flows. Most of the soils formed in place, but in small areas they formed in material moved by gravity. The original vegetation was Douglas-fir, grand fir, hemlock, western redcedar, and Oregon white oak. The understory plants were vine maple, salal, Oregongrape, ferns, and grasses. The annual precipitation is 45 to 80 inches.

Olympic soils are used for timber, bay, pasture, and row crops.

Olympic clay loam, 8 to 20 percent slopes (OlD).-This soil is on rolling, strongly sloping mountain foot slopes and long straight side slopes below ridgetops. In most places the slope is 10 to 15 percent.

In a typical profile the surface layer is dark reddish-brown clay loam about 13 inches thick. The next layer is 46 inches thick. In sequence from the top, the upper 7 inches is friable, dark reddish-brown clay loam; the next 12 inches is firm, reddish-brown heavy clay loam; and the lower 15 inches is very firm, dark-brown gravelly clay loam. The underlying material is weathered basalt bedrock.

This soil is well drained and moderately slowly permeable. It is easily tilled. Roots penetrate to the bedrock. The available water capacity is high, and fertility is moderate. Surface runoff is medium, and the hazard of erosion is moderate if the surface is left bare.

Representative profile of Olympic clay loam, in a forested area about 1 mile south of Venersborg, about 20 feet east of logging road, 500 feet south of the Westerholm road, half a mile east of its junction with County Roads No. 86 and No. 87, NW1/4NE1/4SW1/4 sec. 10, T. 3 N., R. 3 E.

O1-1 inch to 1/4 inch, needles, leaves, and twigs.

O2-1/4 inch to 0, decomposed needles, leaves, and twigs.

A11-0 to 7 inches, dark reddish-brown (5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; moderate, very fine, subangular blocky structure ; hard, friable, sticky and plastic ; many fine, medium, and large roots ; weathered basalt pebbles, 2 to 5 millimeters in diameter, make up 7 percent of this horizon ; medium acid; clear, wavy boundary. (6 to 8 inches thick)

A12-7 to 13 inches, dark reddish-brown (5YR 3/2) clay loam, reddish brown (5YR 4/3) when dry ; strong, fine, subangular blocky structure ; hard, friable, sticky and plastic ; many fine and medium roots ; weathered basalt pebbles, 2 to 10 millimeters in diameter make up 6 percent of this horizon ; strongly acid; clear, wavy boundary. (5 to 7 inches thick)

B21t-13 to 20 inches, dark reddish-brown (5YR 3/4) clay loam, reddish brown (5YR 4/4) when dry; moderate, fine, subangular blocky structure; hard, friable, sticky and plastic ; many fine, fibrous roots ; many fine, tubular pores ; thin, patchy clay films on surfaces ; weathered basalt pebbles, 2 to 5 millimeters in diameter, make up 5 percent of this horizon; medium acid; clear, wavy boundary. (6 to 8 inches thick)

B22t-20 to 32 inches, reddish-brown (5YR 4/4) heavy silty clay loam, reddish brown (5YR 5/4) when dry; moderate, fine, subangular blocky structure and moderate, fine, angular blocky ; hard, firm, plastic and sticky ; common, fine, fibrous roots ; common, medium and coarse, tubular pores ; medium, patchy clay films on ped surfaces and in pores; weathered basalt pebbles, 2 to 3 millimeters in diameter, make up 1 percent of this horizon ; medium acid ; clear, wavy boundary. (10 to 14 inches thick)

B23t-32 to 44 inches, yellowish-red (5YR 4/6) heavy clay loam, yellowish red (5YR 5/4) when dry; moderate, fine, subangular blocky structure and moderate, fine, angular blocky ; very hard, firm, very sticky and very plastic ; common, fine, fibrous roots ; common fine pores ; medium, continuous clay films ; strongly acid ; clear, wavy boundary. (10 to 14 inches thick)

B3-44 to 59 inches, dark-brown (7.5YR 4/4) gravelly clay loam, brown (7.5YR 5/4) when dry ; massive ; strongly fractured, angular blocky, strongly weathered basalt ; extremely hard, very firm, sticky and plastic ; few fine roots ; very few, fine, tubular pores ; thin, continuous reddish-brown (5YR 4/4) clay films coating basalt between fractures ; strongly acid; clear, wavy boundary. (12 to 16 inches thick)

R-59 inches, strongly weathered basalt; many coarse, thick, black (5YR 2/1) manganese segregations coating surfaces between fractures.

The A1 horizon ranges from very dark brown to dark reddish brown in color. The hue ranges from 7.5YR to 5YR. The B horizon ranges from heavy silty clay loam to· heavy clay loam in texture and from medium acid to very strongly acid in reaction. The thickness of the solum overlying bedrock ranges from 40 inches to more than 6 feet. Rock outcrops occur in places.

Clover, ryegrass, orchardgrass, and tall fescue are the principal crops. Oats are grown as part of the common

cropping sequence of 1 year of oats and 4 to 5 years of legumes and grass. Row crops are suited, but they are not generally grown where the slope is more than 10 percent. (Capability unit IIIe-1; woodland suitability group 3oH4 ; wildlife site 7)

Olympic clay loam, 3 to 8 percent slopes (OlB).-This soil is on ridgetops and benches. It is similar to Olympic clay loam, 8 to 20 percent slopes, except that it is not so steep and the surface layer is generally 1 to 3 inches thicker. In a few small areas, the slope is less than 3 percent. Surface runoff is slow, and the hazard of erosion is slight.

Row crops, such as corn, strawberries, and pole beans, are grown in rotation with clover and grass. In many areas sprinkler irrigation is used to increase crop production (fig. 12). (Capability unit IIe-4; woodland suitability group 3oH4; wildlife site 7)

Olympic clay loam, 20 to 30 percent slopes (OlE).-This soil is on long valley slopes and short slopes along drainageways. It is similar to Olympic clay loam, 8 to 20 percent slopes, except that it is steeper and the surface layer is generally 1 to 2 inches thinner. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe if the surface is left bare.

This soil is used for timber. Some cleared areas are in pasture. (Capability unit IVe-4; woodland suitability group 3oH4; wildlife site 7)

Olympic clay loam, 30 to 60 percent slopes (OlF).-This soil is on long, steep side slopes in the mountains and on short slopes that lead into drainageways in the foothills. It is similar to Olympic clay loam, 8 to 20 percent slopes, except that it is very steep and the surface layer is commonly 2 to 4 inches thinner. In many places this soil formed in material that moved down slope through gravity. Some of the steeper areas are still unstable, and the soil layers are not so distinct as they are in the typical Olympic soils. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare.

This soil is used mainly for timber. (Capability unit VIe-3; woodland suitability group 3rM4; wildlife site 7)

Olympic stony clay loam, 3 to 30 percent slopes (OmE).-This soil is on ridgetops, on long side slopes, and on short slopes along drainageways. It is similar to Olympic clay loam, 8 to 20 percent slopes, except that the surface layer is stony and the slope range is greater. The available water capacity is moderate. Surface runoff is slow to rapid, and the hazard of erosion is slight to severe.

The stony surface limits use of the soil mostly to timber or to light grazing in clear-cut areas. (Capability unit VIe-1; woodland suitability group 3fM3 ; wildlife site 12)

Olympic stony clay loam, 30 to 60 percent slopes (OmF).-This soil is on long side slopes in the mountains and on short slopes along drainageways in the foothills. It is similar to Olympic clay loam, 8 to 20 percent slopes, except that it is very steep and the surface layer is stony. In places this soil developed in material moved through gravity. Some of these areas are still unstable. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare.

Figure 12.-Irrigated pasture of Ladino clover and orchardgrass on Olympic clay loam, 3 to 8 percent slopes. Other Olympic soils are in the background.

The slope and the stony surface layer limit use of this soil to timber. (Capability unit VIe-4; woodland suitability group 3rM4; wildlife site 12)

Olympic clay loam, shallow variant, 3 to 15 percent slopes (OpC).-This soil is on benches that are dissected by steep and very steep slopes that lead into creeks and drainageways. It occurs on remote mountainous terraces.

In a typical profile the surface layer is dark reddish-brown clay loam about 13 inches thick. The next layer is 17 inches thick. The upper 7 inches is friable, dark reddish-brown heavy clay loam; the lower 10 inches is firm, reddish-brown heavy silty clay loam. The underlying material is basalt bedrock.

This soil is well drained and moderately slowly permeable. Tillage is easy. Roots penetrate to bedrock. The available water capacity is moderately high, and fertility is moderate. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

Representative profile of Olympic clay loam, shallow variant, 3 to 15 percent slopes, in a forested area, east quarter corner of sec. 19, T. 4 N., R. 4 E.

O1-1 to 1/4 inch, needles, leaves, and twigs.

O2-1/4 inch to 0, decomposed needles, leaves, and twigs.

A11-0 to 7 inches, dark reddish-brown (5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic ; many fine, medium, and large roots; 10 percent of this horizon is weathered basalt gravel, 2 to 5 millimeters in diameter ; medium acid; clear, wavy boundary. (6 to 8 inches thick)

A12-7 to 13 inches. dark reddish-brown. (5YR 3/2) clay loam, reddish brown (5YR 4/3) when dry; strong, fine, subangular blocky structure ; hard, friable, sticky and plastic ; many fine and medium roots ; 10 percent of this horizon is weathered basalt gravel; strongly acid; clear, wavy boundary. (5 to 7 inches thick)

B21t-13 to 20 inches, dark reddish-brown (5YR 3/4) heavy clay loam, reddish brown (5YR 4/4) when dry; moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; many, fine, fibrous roots ; many, fine, tubular pores ; thin, patchy clay films on surfaces; weathered basalt gravel makes up 5 percent of this horizon ; medium acid; clear, wavy boundary. (6 to 8 inches thick)

B22t-20 to 30 inches, reddish-brown (5YR 4/4) heavy silty clay loam, reddish brown (5YR 5/4) when dry; moderate, fine, subangular blocky structure and moderate, fine, angular blocky ; hard, firm, plastic and sticky ; common, fine, fibrous roots; common, medium and coarse, tubular pores ; medium, patchy clay films on ped surfaces and in pores ; weathered basalt gravel makes up 5 percent of this horizon ; medium acid ; clear, wavy boundary. (10 to 13 aches thick)

R-30 inches, basalt bedrock.

The thickness of the solum and the depth to bedrock range from 30 to 36 inches.

This soil is well suited to timber. Capability unit IVe-3; woodland suitability group 3rL6; wildlife site 7)

Olympic clay loam, shallow variant, 15 to 30 percent slopes (OpE).-This soil is in mountainous terrain on long, steep side slopes of ridges and on short, steep side slopes of drainageways. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe if the surface is left bare.

Timber is suited to this soil. (Capability unit VIe-1; woodland suitability group 3dM5; wildlife site 7)

Olympic clay loam, shallow variant, 30 to 65 percent slopes (OpG).-This soil is in mountainous terrain on long side slopes of ridges and on short slopes that lead into drainageways. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare.

The slope limits use of this soil to timber. (Capability unit VIe-3; woodland suitability group 3rM4; wildlife site 7)

Olympic very stony clay loam, shallow variant, 5 to 15 percent slopes (OrC).-This soil is in mountainous terrain on ridgetops and benches. It is similar to Olympic clay loam, shallow variant, 3 to 15 percent slopes, except that the surface is very stony.

Timber is suited to this soil. (Capability unit VIs-1; woodland suitability group 3dM5; wildlife site 12)

Pilchuck Series

The Pilchuck series consists of deep, somewhat excessively drained, nearly level to gently sloping soils along streams. These are sandy soils that formed in parent material of recent sandy alluvium deposited by streams. These soils are subject to flooding where not protected by dikes. The original vegetation was cottonwood, willow, hazel, Scotchbroom, and grasses. The annual precipitation is 40 to 60 inches.

Pilchuck soils are used for hardwoods and, to some extent, for pasture, hay, and oats.

Pilchuck fine sand, 0 to 8 percent slopes (PhB).-This soil is on terraces along streams. It is subject to overflow and deposition during periods when the water level is high. The slopes are generally undulating and in most places are less than 5 percent.

In a typical profile the surface layer is very dark gray and gray fine sand about 6 inches thick. The next layer, to a depth of 60 inches, is very dark gray and gray fine sand.

Included in mapping were a few areas, mostly terrace fronts, where the slope is more than 8 percent. Also included were small areas where the subsurface layers are thin and small areas that contain up to 40 percent pumice. Some areas were included where olive-brown mottles occur below the surface layer. A few areas were included where lenses of finer textured material, 4 to 8 inches thick, occur within 40 inches of the surface.

This soil is somewhat excessively drained and rapidly permeable. It is easily tilled. Roots penetrate to a depth of more than 48 inches. The available water capacity and fertility are low. Surface runoff is very slow. The hazard of erosion is normally slight unless there is flooding, at which time the erosion hazard is severe.

Representative profile of Pilchuck fine sand, in a grain field about 100 feet west of field entrance, SE1/4NE1/4 sec. 10, T. 5 N., R. 1 E.

Ap-0 to 6 inches, very dark gray (10YR 3/1) and gray (10YR 5/1) fine sand, dark gray (10YR 4/1) and gray (10YR 6/1) when dry ; single grain ; loose ; nonsticky and nonplastic ; many fine roots ; slightly acid; abrupt, smooth boundary. (4 to 6 inches thick)

C1-6 to 21 inches, very dark gray (10YR 3/1) and gray (10YR 5/1) fine sand, dark gray (10YR 4/1) and gray (10YR 6/1) when dry; single grain ; loose ; non-

sticky and nonplastic ; common fine roots; neutral ; gradual, smooth boundary. (13 to 17 inches thick)

C2-21 to 60 inches, very dark gray (10YR 3/1) and gray (10YR 5/1) fine sand, dark gray (10YR 4/1) and gray (10YR 6/1) when dry; single grain; loose; nonsticky and nonplastic ; few fine roots ; neutral. (Many feet thick)

The A horizon ranges from medium sand to loamy fine sand in texture.

Droughtiness limits use of this soil mostly to native grasses and to cottonwood production for pulp. If sprinkler irrigation is used and fertilizer is applied, such crops as alfalfa, clover, grasses, and grain can be grown. (Capability unit VIs-2; woodland suitability group 2sH3; wildlife site 10)

Powell Series

The Powell series consists of moderately well drained, nearly level to steep soils underlain by a fragipan at a depth of 23 to 36 inches. These are medium-textured soils that formed in old alluvial silt. The terrain is rolling. The original vegetation was Douglas-fir, grand fir, western redcedar, Oregon ash, and Oregon white oak. The understory was vine maple, salal, Oregongrape, grasses, and ferns. The annual precipitation is about 50 inches.

Powell soils are used for row crops, hay, pasture, and timber.

Powell silt loam, 0 to 8 percent slopes (PoB).-This soil is on ridgetops, benches, and gently sloping side slopes that lead into valleys in the Prune Hill area. In most places the surface layer is smooth and convex, and the slope is less than 6 percent.

In a typical profile the surface layer is dark-brown silt loam about 17 inches thick. Below the surface layer is friable, mottled, grayish-brown and brown silt loam about 6 inches thick. The next layer is brittle and about 22 inches thick. It is firm, dark yellowish-brown silt loam in the upper part, and firm, mottled, brown heavy silt loam in the lower part. Below this layer, to a depth of 63 inches, is firm, mottled, dark-brown heavy silt loam.

This soil is moderately well drained. The subsoil is slowly permeable. Roots penetrate to the subsoil, but very few go into it. The available water capacity and fertility are moderate. This soil is easily tilled, except early in spring, when the soil tends to be wet and, in some areas, seepy. A perched water table during the rainy season normally limits use of deep-rooted crops. Surface runoff is slow, and the hazard of erosion is slight.

Representative profile of Powell silt loam, in a pasture about 3/8 mile south of County Road No. 119 on County Road No. 122, SW1/4SW1/4NW1/4 sec. 4, T. 1 N., R. 3 E.

Ap-0 to 8 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 4/3) when dry; moderate, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium roots; medium acid; abrupt, smooth boundary. (6 to 10 inches thick)

A1-8 to 17 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; moderate, medium and coarse, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine and medium roots ; many fine pores; strongly acid; clear, wavy boundary. (6 to 12 inches thick)

A&B--17 to 23 inches, the A2 part of this horizon is grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) when dry; common, fine, distinct, yellowish-red (5YR 5/8) mottles; the B part of this horizon is brown (7.5YR 4/4) silt loam, yellowish brown (10YR 5/4) when dry ; weak, medium, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine and medium roots ; many fine and medium pores ; few black manganese stains ; medium acid; clear, wavy boundary. (3 to 8 inches thick)

Bxl-23 to 29 inches, dark yellowish-brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) when dry; weak, medium, prismatic structure; hard, firm, brittle, slightly sticky and slightly plastic; few fine roots ; few large pores, many fine pores ; thin clay films in pores, dark reddish brown when dry ; common, fine, black manganese stains ; thin, gray silica coatings on ped surfaces and in some pores ; strongly acid; clear, wavy boundary. (5 to 8 inches thick)

Bx2-29 to 45 inches, brown (10YR 4/3) heavy silt loam, light yellowish brown (10YR 6/4) when dry; yellowish-red (5YR 4/6) mottles and few, light brownish-gray (10YR 6/2) mottles; moderate, coarse, prismatic structure ; hard, firm, brittle, slightly sticky and plastic ; few fine roots ; common fine pores, few large pores ; thin, patchy clay films on ped surfaces and in pores; common black manganese stains on ped surfaces ; gray silica coatings on ped surfaces and in some pores ; strongly acid ; gradual, wavy boundary. (10 to 20 inches thick)

B3-45 to 63 inches, dark-brown (10YR 4/3) heavy silt loam, yellowish brown (10YR 5/4) when dry; common, brown (7.5YR 4/4) mottles and few, light brownishgray (10YR 6/2) mottles; weak, coarse, prismatic structure ; hard, firm, slightly sticky and plastic ; no roots ; many fine and medium pores ; thin clay films in pores ; common black manganese stains on ped surfaces ; medium acid.

The A1 horizon ranges from dark brown (10YR 3/3) to very dark gray (10YR 3/1). The B horizon ranges from silt loam to heavy silt loam in texture, and, when the soil is moist, the value ranges from 4 to 5 and the chroma from 3 to 4. The fragipan characteristics range from marginal to distinct. The depth to the fragipan ranges from 23 to 36 inches.

The principal crops are hay (fig. 13), pasture, and corn for silage. There are small acreages of strawberries, grain, and prunes. (Capability unit IIIe-4; woodland suitability group 3dL6; wildlife site 4)

Powell silt loam, 8 to 20 percent slopes (PoD).-This soil is on long, smooth side slopes below ridges and at the foot slopes of steep areas. It is similar to Powell silt loam, 0 to 8 percent slopes, except that it is steeper and the surface layer is 1 to 3 inches thinner. Surface runoff is medium, and the hazard of erosion is moderate.

The principal crops are hay, pasture, and corn for silage. There are small acreages of strawberries, grain, and prunes. Grasses and legumes are grown on more of this soil than on Powell silt loam, 0 to 8 percent slopes. The slope limits row cropping. Grain is grown in rotation with long-lived legumes and grasses. Some areas are in timber. (Capability unit IIIe-1; woodland suitability group 3dL6; wildlife site 4)

Powell silt loam, 20 to 30 percent slopes (PoE).-This soil is on long, smooth side slopes. It is similar to Powell silt loam, 0 to 8 percent slopes, except that it is steeper and the surface layer is 1 to 3 inches thinner. In about 10 percent of the acreage the slope is more than 30 percent. Surface runoff is medium to rapid, and the erosion

Figure 13.-Birdsfoot trefoil and orchardgrass; grown for hay on Powell silt loam, 0 to 8 percent slopes. Powell silt loam, 20 to 30 percent slopes, is in the background. This area is near Camas.

hazard is moderate to severe if the surface is left bare.

The slope limits use of this soil to timber or perennial pasture. (Capability unit IVe-4; woodland suitability group 3dL6; wildlife site 4)

Puyallup Series

The Puyallup series consists of somewhat excessively drained, mostly nearly level to gently sloping soils that are shallow or moderately shallow over sand and gravel. These are loamy, stratified soils that formed in material of mixed origin on alluvial bottom lands along the Lewis River and the East Fork of the Lewis River. The original vegetation was cottonwood, willow, grasses, and weedy plants. The annual precipitation is 40 to 60 inches.

Puyallup soils are used for row crops, hay, pasture, and orchards.

Puyallup fine sandy loam, 0 to 3 percent slopes (PuA).-This soil is on low terraces along the Lewis River and the East Fork of the Lewis River.

In a typical profile the surface layer is about 18 inches thick. In sequence from the top, the upper 4 inches is very dark brown fine sandy loam; the next 4 inches is very dark grayish-brown loam; and the lower part is dark-brown fine sandy loam. Below the surface layer is loose, dark-brown loamy sand about 9 inches thick. The under lying material, to a depth of 60 inches, is very dark grayish-brown gravelly sand.

Included in mapping were a few small areas of Newberg and Cloquato soils.

This soil is somewhat excessively drained. Permeability is moderately rapid in the uppermost part of the profile and rapid in the lower part. The available water capacity and fertility are moderate. The soil is easy to work and can be cultivated throughout a wide range of moisture content. Surface runoff is very slow, and there is no erosion hazard. Undiked low areas next to the rivers are subject to flooding in winter.

Representative profile of Puyallup fine sandy loam in a cultivated area approximately 400 feet south and 600 feet west of the east quarter corner of sec. 19, T. 4 N., R. 2 E.

Ap-0 to 4 inches, very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and coarse, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine and medium roots ; slightly acid ; abrupt, smooth boundary. (3 to 5 inches thick)

A11-4 to 8 inches, very dark grayish-brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) when dry ; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; abundant fine and medium roots ; medium acid; clear, smooth boundary. (3 to 5 inches thick)

A12-8 to 18 inches, dark-brown (10YR 3/3) fine sandy loam, grayish brown (10YR 5/2) when dry; weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic ; common fine root: ; many fine and medium pores, few large pores; slightly acid; abrupt, wavy boundary. (8 to 12 inches thick)

C1-18 to 27 inches, dark-brown (10YR 3/3) loamy sand, grayish brown (10YR 3/2) when dry; single grain; loose, nonsticky and nonplastic ; few fine roots ; slightly acid; abrupt, wavy boundary. (8 to 15 inches thick)

IIC2-27 to 60 inches, very dark grayish-brown (2.5Y 3/2) gravelly sand, grayish brown (2.5Y 5/2) when dry; single grain ; loose, nonsticky and nonplastic ; no roots; neutral.

The surface 8 inches ranges from fine sandy loam to loam in texture and from very dark brown to very dark grayish brown in color. The depth to gravelly sand, loamy sand, or sand ranges from 16 to 40 inches.

Nearly all the acreage is used for hay and pasture. Truck crops, such as corn and pole beans, are well suited when grown under sprinkler irrigation. (Capability unit IIIs-1; wildlife site 2; not assigned to a woodland suitability group)

Riverwash (Sandy)

Riverwash (sandy) (Ra) consists of nearly level, unconsolidated sandy alluvium on streambanks along major rivers. This miscellaneous land type supports little or no vegetation. It is subject to continual change as the river level fluctuates and to further modification by channel dredging. The areas are valuable for recreational purposes and as a source of sand. (Capability unit VIIIw-1; not assigned to a woodland suitability group nor a wildlife site)

Riverwash (Cobbly)

Riverwash (cobbly) (Rc) consists of nearly level, recently deposited, unconsolidated alluvium that is stratified and variable in texture. Many areas are gravelly, cobbly, and stony and are subject to frequent changes through periodic stream overflow. This miscellaneous land type supports little or no vegetation and has no farming value. Some areas are a source of gravel; others are used for recreational purposes. (Capability unit VIIIw-1; not assigned to a woodland suitability group nor a wildlife site)

Rock Land

Rock land (Rk) consists of steep and very steep areas made up largely of rock outcrops and very shallow soil. Most of this land type is in the mountainous eastern and northeastern parts of the county. The areas are valuable for recreational purposes, wildlife habitat, and water yield. (Capability unit VIIIs-2; not assigned to a woodland suitability group nor a wildlife site)

Rough Broken Land

Rough broken land (Ro) consists of very steep terrace fronts and areas of very steep land, which are broken by intermittent drainage channels. Soil slippage is common, and the very steep slopes have a succession of short vertical exposures. Surface runoff is very rapid. This unit is valuable for wildlife habitat and water yield. (Capability unit VIIIe-1; not assigned to a woodland suitability group nor a wildlife site)

Salkum Series

The Salkum series consists of deep, well-drained, gently sloping to sloping soils underlain by slowly permeable silty clay loam or silty clay that contains many rounded, strongly weathered, rotten, pebble- and cobblestone-size fragments. These are moderately fine textured soils that formed on terraces in old sediments derived from basic Igneous rock. The original vegetation was Douglas-fir. The understory plants were vine maple, salal, Oregongrape and ferns. The annual precipitation is about 50 inches.

Salkum soils are used mainly for small grain, grass, clover, and timber.

Salkum silty clay loam, 3 to 15 percent slopes (SaC).- This soil occupies upland terraces.

In a typical profile the surface layer is silty clay loam about 8 inches thick. It is very dark brown in the upper part and dark brown in the lower part. Below the surface layer is heavy silty clay loam about 23 inches thick. The upper 6 inches is firm and dark brown; the lower part is very firm and brown. The underlying material, to a depth of 55 inches, is mottled gray, yellow, and brown heavy silty clay loam.

This soil is well drained and slowly permeable. The available water capacity is very high. Fertility is low. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate. Plows do not scour well, and there are other tillage problems.

Representative profile of Salkum silty clay loam, in woodland on the north side of Underwood Road, 350 feet west of the southeast corner of sec. 32, T. 5N., R. 2 R E.

O2-1 1/2 inches to 0, moss and partly decomposed leaves, needles, twigs, and grass.

A11-0 to 4 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many roots ; slightly acid ; abrupt, smooth boundary. (3 to 6 inches thick)

A12-4 to 8 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 5/3) when dry ; moderate, fine, subangular blocky structure and moderate, fine, granular; slightly hard, friable, slightly sticky and slightly plastic ; many roots ; common fine pores ; strongly acid ; clear, wavy boundary. (3 to 6 inches thick)

B1-8 to 14 inches, dark-brown (7.5YR 3/4) heavy silty clay loam, yellowish brown (10YR 5/4) when dry; moderate, fine and very fine, subangular blocky structure ; hard, firm, sticky and plastic ; common roots ; common fine pores ; strongly acid ; clear, smooth boundary. (5 to 8 inches thick)

B21t-14 to 23 inches, brown (7.5YR 4/4) heavy silty clay loam, yellowish brown (10YR 5/4) when dry ; moderate, fine, subangular blocky structure; very hard, very firm, very sticky and plastic ; few roots ; few fine and very fine pores; thin, patchy clay films on ped surfaces ; strongly acid ; clear, wavy boundary. (8 to 12 inches thick)

B22t-23 to 31 inches, brown (7.5YR 4/4) heavy silty clay loam, light yellowish brown (10YR 6/4) when dry ; moderate, fine, subangular blocky structure; very

hard, very firm, very sticky and plastic ; no roots ; common fine and very fine pores ; thin, patchy clay films on ped surfaces ; very strongly acid; abrupt, wavy boundary. (6 to 10 inches thick)

IIC-31 to 55 inches, mottled gray, yellow, and brown (7.5YR and 10YR hues) heavy silty clay loam; massive; hard, firm, sticky and plastic ; common fine and very fine pores ; many rotted pebble- acid cobblestone-size fragments and a few hard fragments; very strongly acid. (Many feet thick)

When the soil is moist, the A horizon ranges from 10YR 2/2 to 7.5YR 3/2 in color. The solum overlying the slowly permeable horizons ranges from 20 to 40 inches in thickness. The B2t horizon ranges from 5YR to 10YR in line and from moderate to strong in structure. The B2t and C horizons range from silty clay loam to silty clay in texture.

This soil is used for small grain, grass, clover, and timber. In cultivated areas tillage across the slope or on the contour helps control erosion. (Capability unit IIIe-1; woodland suitability group 3dM5; wildlife site 7)

Sara Series

The Sara series consists of deep, moderately well drained, nearly level to very steep soils. These are loamy soils that formed on terraces in old alluvial deposits that contained volcanic ash in the upper part. The original vegetation was Douglas-fir, grand fir, and a few stands of redcedar and Oregon white oak. The understory plants were vine maple, salal, Oregongrape, ferns, and grasses. The annual precipitation is about 45 inches.

Sara soils are used for hay, pasture, and row crops (fig. 14).

Sara silt loam, 0 to 8 percent slopes (SlB).-This soil is on the tops of ridges. In most places the slopes are long and smooth.

In a typical profile the surface layer is dark-brown silt loam about 10 inches thick. The next layer is firm, mottled, dark-brown silty clay loam about 7 inches thick. The next layer is about 53 inches thick. The first 8 inches of this layer is firm, mottled, dark grayish-brown silty clay loam; the next 13 inches is very firm, mottled, dark grayish-brown silty clay; the next 10 inches is extremely firm, mottled, dark grayish-brown silty clay loam; the next 22 inches is very firm, dark-brown silty clay loam; and the lower 26 inches, to a depth of 96 inches, is very firm, strong-brown silty clay loam.

This soil is moderately well drained and easily tilled. It is moderately permeable in the upper layers and very slowly permeable in the lower layers. The available water capacity is moderately high, and fertility is moderate. A perched water table in winter and early in spring severely limits the growth of such deep-rooted crops as alfalfa. Seep areas are numerous in winter and spring. Surface runoff is slow, and the hazard of water erosion is slight.

Representative profile of Sara silt loam in a cultivated area 1,900 feet east of County Road No. 19 on the William Blank Road and 300 feet north in field, SW1/4SE1/4 sec. 4, T. 3 N., R. 1 E.

Ap1-0 to 5 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/4) when dry ; moderate, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic; many fine roots ; medium acid ; abrupt, smooth boundary. (4 to 7 inches thick)

Ap2-5 to 10 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/4) when dry; moderate, medium, platy structure ; hard, firm, slightly sticky and slightly plastic ; many fine roots ; many fine and medium pores ; medium acid ; abrupt, smooth boundary. (4 to 7 inches thick)

A&B1-10 to 17 inches, dark-brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) when dry;

Figure 14.-An area of Sara silt loam that has been prepared for cultivation. This area is used for hay, pasture, and row crops.

common, fine, faint, strong-brown (7.5YR 5/6) mottles; moderate, fine, subangular blocks structure very hard, firm, sticky and plastic ; common fine roots on ped surfaces ; many fine pores; medium, patchy clay films on ped surfaces ; few fine, black manganese segregations; thin, light-gray (10YR 7/2) coatings on dry ped surfaces ; very strongly acid ; abrupt, wavy boundary. (5 to 10 inches thick)

A&B2-17 to 25 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, yellowish brown (10YR 5/4) when dry; strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure breaking to moderate, fine, angular blocky ; extremely hard, firm, sticky and plastic ; few fine roots on pod surfaces ; many fine pores ; moderate, continuous, dark-brown (7.5YR 4/4) clay films in pores and on ped surfaces; few, fine, black, manganese segregations; gray (10YR 6/1) coatings on peds; very strongly acid; clear, wavy boundary. (7 to 12 inches thick)

B&A1-25 to 38 inches, dark grayish-brown (10YR 4/2) silty clay, pale brown (10YR 6/3) when dry ; fine, distinct, dark-brown mottles ; moderate, medium, prismatic structure breaking to strong, fine, angular blocky ; extremely hard, very firm, very sticky and very plastic ; no roots ; common fine pores ; thick, continuous clay films ; thick tongues of A2 horizon, gray (10YR 6/1) and white (10YR 8/1) when dry; extremely acid; abrupt, wavy boundary. (10 to 14 inches thick)

B&A2-38 to 48 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, pale brown (10YR 6/3) when dry; medium, distinct, dark reddish-brown (5YR 3/3) mottles; moderate, medium, angular blocky structure ; extremely hard, extremely firm, sticky and plastic; common fine pores; thick, continuous clay films; 5 percent of this horizon is black manganese segregations, 3 to 5 millimeters in size; dark grayish-brown (10YR 4/2) coatings on peds, light gray (10YR 7/1) when dry; extremely acid; gradual, wavy boundary. (8 to 12 inches thick)

B&A3-48 to 70 inches, dark-brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) when dry; weak, fine and medium, subangular blocky structure; extremely hard, very firm, sticky and plastic ; few fine pores ; thick, continuous clay films : light-gray (10YR 7/2), when dry, tongues of material from A2 horizon, 1/2 inch to 1 inch thick, between major ped surfaces, extending into horizon below ; many, medium, black manganese segregations on surfaces; very strongly acid ; clear, wavy boundary.

B&A4-70 to 96 inches, strong-brown (7.5YR 5/3) silty clay loam, reddish yellow (7.5YR 6/8) when dry; weak, coarse, prismatic structure breaking to moderate, medium and fine, angular blocky ; extremely hard, very firm, very sticky and very plastic; few fine pores ; thick, continuous clay films ; common, coarse, black manganese segregations, white (10YR 8/1) when dry; tongues of material from A2 horizon, 1/2 inch to 1 inch thick, extending downward between major ped surfaces (4 to 6 inches apart; very strongly acid.

When the soil is moist, the A horizon ranges from 10YR to 7.5YR in hue, from 2 to 3 in chroma. The B&A horizon ranges from heavy silty clay loam to silty clay in texture. The consistence of this horizon ranges from firm to very firm when the soil is moist, very hard to extremely hard when dry, and sticky and plastic to very sticky and very plastic when wet. The chroma ranges from 2 to 3 when the soil is moist and from 5 to 6 when dry. The rooting zone ranges from 20 to 40 inches in thickness.

Hay, pasture, and grain are the principal crops. A few acres of strawberries, potatoes, pole bean, and corn are grown in rotation with grasses and legumes. (Capability unit IIIe-4; woodland suitability group 3dL6; wildlife site 4)

Sara silt loam, 8 to 20 percent slopes (SlD).-This soil is on the edges of ridges and on sidehills. It is similar to Sara silt loam, 0 to 8 percent slopes, except that the surface layer is 2 to 3 inches thinner. Most slopes are medium in length. Surface runoff is medium, and the hazard of erosion is moderate.

Hay, pasture, and grain are the principal crops, but grasses and legumes are grown more extensively on this soil than on Sara silt loam, 0 to 8 percent slopes. Some row crops are grown, but the acreage is small. Contour and cross-slope planting reduces the erosion hazard when the soil is used for row crops. (Capability unit IIIe-1; woodland suitability group 3dL6; wildlife site 4)

Sara silt loam, 30 to 50 percent slopes (SlF).-This soil is on slopes that lead into drainageways. It is similar to Sara silt loam, 0 to 8 percent slopes, except that the surface layer is about 6 or 7 inches thick. The slopes are generally short. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe on areas without vegetative cover.

The slope limits use mostly to timber. (Capability unit VIe-3 ; woodland suitability group 3rL6 ; wildlife site 4)

Sauvie Series

The Sauvie series consists of deep, moderately well drained and somewhat poorly drained, mostly nearly level to gently sloping soils (fig. 15) on bottom lands along the Columbia River. These are loamy soils that formed in alluvium. The native vegetation is willows, cottonwoods, and native grasses. The annual precipitation is 40 to 60 inches.

Sauvie soils are used for row crops, hay, and pasture.

Sauvie silty clay loam, 0 to 8 percent slopes (SpB).-This soil is on the broad tops of old natural levees on the bottom lands along the Columbia River. In most places the slopes are smooth or gently undulating.

In a typical profile the surface layer is very dark grayish-brown silty clay loam about 15 inches thick. Below the surface layer is friable, mottled, dark grayish-brown silty clay loam about 21 inches thick. The next layer, to a depth of 63 inches, is mottled, grayish-brown silt loam.

This soil is somewhat poorly drained and has moderately slow permeability. The available water capacity is very high, and fertility is high. Tillage is easy, except when the soil is wet. Surface runoff is slow. The hazard of erosion is slight, except in some areas that are subject to flooding from the Columbia River, where scouring can be a severe erosion hazard. A high water table is common in winter and spring.

Representative profile of Sauvie silty clay loam in a pasture about 900 feet east of sharp left turn in Lower River Road on bank of Vancouver Lake, SW1/4SW1/4NWWW1/4 sec. 7, T. 2 N., R. 1 E.

A11-0 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; many, fine, faint, dark-brown (10YR 3/3) mottles ; strong, fine, subangular blocky structure ; hard, friable, sticky and plastic ; many roots; slightly acid; clear, wavy boundary. (6 to 8 inches thick)

A12-7 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; many, fine, faint, dark-brown (10YR 3/3) mottles ; moderate, medium, prismatic structure breaking

Figure 15.-An area of Sauvie loam near Ridgefield. This soil is on bottom lands along the Columbia River.

to moderate, very fine, subangular blocky ; very hard, friable, sticky and plastic ; few roots ; many very fine and medium, and few coarse pores ; slightly acid; abrupt, wavy boundary. (6 to 12 inches thick)

B21g-15 to 26 inches, dark grayish-brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) when dry ; common, medium, distinct dark yellowish-brown (10YR 4/4) mottles; moderate, medium, prismatic structure breaking to moderate, very fine, subangular blocky ; very hard, friable, sticky and plastic ; few roots ; many very fine, medium, and coarse tubular pores; cutans on ped faces, probably result of pressure; slightly acid; clear, smooth boundary. (10 to 12 inches thick)

B22g-26 to 36 inches, dark grayish-brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) when dry; common, medium, distinct, dark-brown (10YR 4/4) mottles; moderate, medium, prismatic structure breaking to moderate, very fine, angular blocky; very hard, friable, sticky and plastic ; few roots ; many very fine, medium, and coarse tubular pores; cutans on ped faces, probably result of pressure ; slightly acid; clear, smooth boundary. (9 to 11 inches thick)

Clg 36 to 43 inches, grayish-brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) when dry; common, medium, distinct, dark-brown (10YR 3/3) mottles; weak, fine, subangular blocky structure; hard, friable, sticky and plastic ; few roots ; many very fine, medium, and coarse tubular pores; cutans on ped surfaces, probably result of pressure; neutral; clear, smooth boundary. (6 to 8 inches thick)

C2g-43 to 63 inches, grayish-brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) when dry; common, medium, distinct, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 4/4) mottles; moderate, medium, prismatic structure breaking to moderate, fine, angular blocky; hard, friable, sticky and plastic ; few roots ; many very fine, medium, and coarse tubular pores; neutral; abrupt, smooth boundary. (19 to 21 inches thick)

The A horizon ranges from 10 to 17 inches in thickness and from silt loam to silty clay loam in texture. A very dark gray to nearly black horizon, about 6 to 12 inches thick, occurs in some places at a depth of 6 to 8 inches below the surface. The chroma ranges from 1 to 2 throughout the profile. In some areas there is a horizon at a depth of 7 to 26 inches that appears as a very dark band in cuts and in river banks. In other areas sand lenses that range from a few inches to several feet in thickness occur in the profile at a depth of more than 36 inches.

Most of the soil is diked to protect it from flooding. All truck crops, row crops, hay, and pasture suited to this area are grown. Molds and fungi cause some problems because of air-moisture relationships in the soil. If truck crops are grown, annual green-manure crops and cover crops are beneficial. (Capability unit IIw-1; wildlife site 1; not assigned to a woodland suitability group)

Sauvie silt loam, 0 to 3 percent slopes (SmA).-This soil is on the broad tops of old natural levees on bottom lands along the Columbia River, and in many of the depressional areas. It is similar to Sauvie silty clay loam, 0 to 8 percent slopes, except that the surface layer is silt loam, the soil is moderately well drained, and there are fewer mottles in the profile. Surface runoff is very slow, and the hazard of erosion is slight. This soil can be cultivated throughout a wide range of moisture content.

All trucks crops, row crops, hay, and pasture suited to this area are grown. This soil is easier to work than Sauvie silty clay loam, 0 to 8 percent slopes, and can be cultivated earlier in spring. Susceptibility to plant diseases caused by molds and fungi is lower because air-moisture relationships in the surface layer are better. (Capability unit IIw-1; wildlife site 1; not assigned to a woodland suitability group)

Sauvie silt loam, 3 to 8 percent slopes (SmB).-This soil is on the side slopes of the old natural levees on bottom lands along the Columbia River. It is similar to Sauvie silty clay loam, 0 to 8 percent slopes, except that it is

moderately well drained, it has fewer mottles in the profile, and the surface layer is silt loam. Surface runoff is slow, and the erosion hazard is slight.

All truck crops, row crops, hay, and pasture suited to this area are grown. Cross-slope farming is needed to reduce surface runoff and soil loss. (Capability unit IIe-2 ; wildlife site 1; not assigned to a woodland suitability group)

Sauvie silt loam, sandy substratum, 0 to 3 percent slopes (SnA).-This soil is on gently undulating, broad, smooth bottom lands along the Columbia River. Included in mapping were a few areas where the slope is up to 8 percent. This soil is similar to Sauvie silty clay loam, 0 to 8 percent slopes, except that the surface layer is silt loam and a substratum of fine sandy loam occurs at a depth below 36 inches. Surface runoff is very slow, and the erosion hazard is slight, except in areas that are subject to flooding. Diking is difficult on this soil because of the permeable fine sandy loam substratum. If this zone is not cut off in diking, water will move through it and break out in areas known locally as "boils" within the diked area in periods when the water level is high.

All truck crops, row crops, hay, and pasture suited to this area are grown. This soil is easier to work and can be cultivated earlier in spring than Sauvie silty clay loam, 0 to 8 percent slopes. Susceptibility to plant diseases caused by molds and fungi is lower because air-moisture relationships in the surface laver are better. (Capability unit IIw-1; wildlife site 1; not assigned to a woodland suitability group)

Semiahmoo Series

The Semiahmoo series consists of deep, very poorly drained, mostly nearly level soils. These are muck soils that formed in organic material in low, wet, basins or depressions on terraces and in stream valleys. The native vegetation consisted largely of sedges, tules, cattails, spirea, hardhack, and other water-tolerant plants. The annual precipitation is 40 to 60 inches.

Semiahmoo soils are used for truck crops, hay, pasture, and specialty crops, such as mint, dill, and flower bulbs.

Semiahmoo muck (Sr).-This soil is in broad basins, or depressions, that were formerly lakes or marshes. In most places the slope is less than 2 percent.

In a typical profile the surface layer is dark reddish-brown muck about 13 inches thick. Below the surface layer is very friable, pale-brown fine sand (pumice) about 2 inches thick. The next layer is 105 inches thick. In sequence from the top, the first 25 inches of this layer is dark reddish-brown muck; the next 16 inches is dark reddish-brown fibrous peat; and the lower 6.1 inches is dark-olive sedimentary peat.

Included in mapping were small areas where the muck and peat is less than 4 feet thick over the mineral soil. Also included were small areas where the surface layer is peat.

This soil is very poorly drained and has moderate permeability. The available water capacity is very high, and fertility is low. The soil is easily tilled and can be cultivated throughout a wide range of moisture content. This soil is susceptible to development of tillage pans. Surface runoff is ponded to very slow, and there is no erosion hazard. Subsidence can be reduced by controlling the water table, which is at or near the surface much of the time in undrained areas.

Representative profile of Semiahmoo muck tinder a cover of mint at Fargher Lake, 700 feet east and 50 feet south of the northwest corner of sec. 25, T. 5 N., R. 2 E.

Ap-0 to 7 inches, dark reddish-brown (5YR 2/2) muck; weak, fine, granular structure ; slightly hard, friable, nonsticky and nonplastic ; many fine roots ; strongly acid; abrupt, smooth boundary. (4 to 8 inches thick)

Oa1-7 to 13 inches, dark reddish-brown (5YR 2/2) muck; weak, medium, prismatic structure (apparent when dry) ; slightly hard, friable, nonsticky and nonplastic ; many fine roots ; strongly acid ; abrupt, smooth boundary. (5 to 16 inches thick)

C1-13 to 15 inches, pale-brown (10YR 6/3) fine sand (pumice), very pale brown (10YR 7/4) when dry; single grain ; soft, very friable, nonsticky and nonplastic ; few fine roots ; strongly acid ; abrupt, smooth boundary. (0 to 2 inches thick)

Oa2-15 to 40 inches, dark reddish-brown (5YR 2/2) muck, dark brown (7.5YR 3/2) when dry; massive; soft, friable, nonsticky and nonplastic ; few fine roots ; strongly acid; gradual, wavy boundary. (10 to 25 inches thick)

Oi-40 to 56 inches, dark reddish-brown (5YR 3/4) fibrous peat composed of raw sedge and reeds, dark brown (10YR 3/3) when dry ; laminated ; soft, friable, nonsticky and nonplastic ; no roots ; medium acid ; abrupt, wavy boundary. (12 to 48 inches thick)

Oe-56 to 120 inches, dark-olive (5Y 3/4) sedimentary peat, light gray (5Y 7/2) when dry; massive; very soft, very friable, nonsticky and nonplastic; neutral.

The thickness of the muck and peat ranges from 4 feet to more than 6 feet. The content of diatomite, which is present in all layers, is variable. Pumicite layers range from 1 to 3 inches in thickness. The surface layer is black, very dark grayish brown, dark reddish brown, or very dark brown, depending upon the degree of decomposition of organic matter, the diatomite content, and the amount of mineral soil overwash.

Peppermint is the principal crop (fig. 16). Some truck crops, such as lettuce, cabbage, and carrots, are grown. Small acreages are used for flower bulbs and other specialty crops, such as dill. Hay and pasture are other crops. Artificial drainage is necessary before most crops can be grown. Open ditches and box drains are used in conjunction with a regulated outlet to control the water table. (Capability unit IIw-2; wildlife site 5; not assigned to a woodland suitability group)

Semiahmoo muck, shallow variant (Su).-This soil is in depressions and basins.

In a typical profile the surface layer is dark reddish-brown muck about 13 inches thick. Below the surface layer is very friable, pale-brown fine sand (pumice) about 2 inches thick. The next layer, to a depth of 30 inches, is dark reddish-brown snuck. The underlying material, to a depth of 60 inches, is mineral soil composed of stratified sand, silt, and clay.

This soil is very poorly drained and has moderate permeability. The available water capacity is very high, and fertility is low. The soil is easily tilled and can be cultivated throughout a wide range of moisture content.

It is susceptible to development of tillage pans. Surface runoff is ponded to very slow, and there is no erosion hazard. Subsidence can be reduced by controlling the water table.

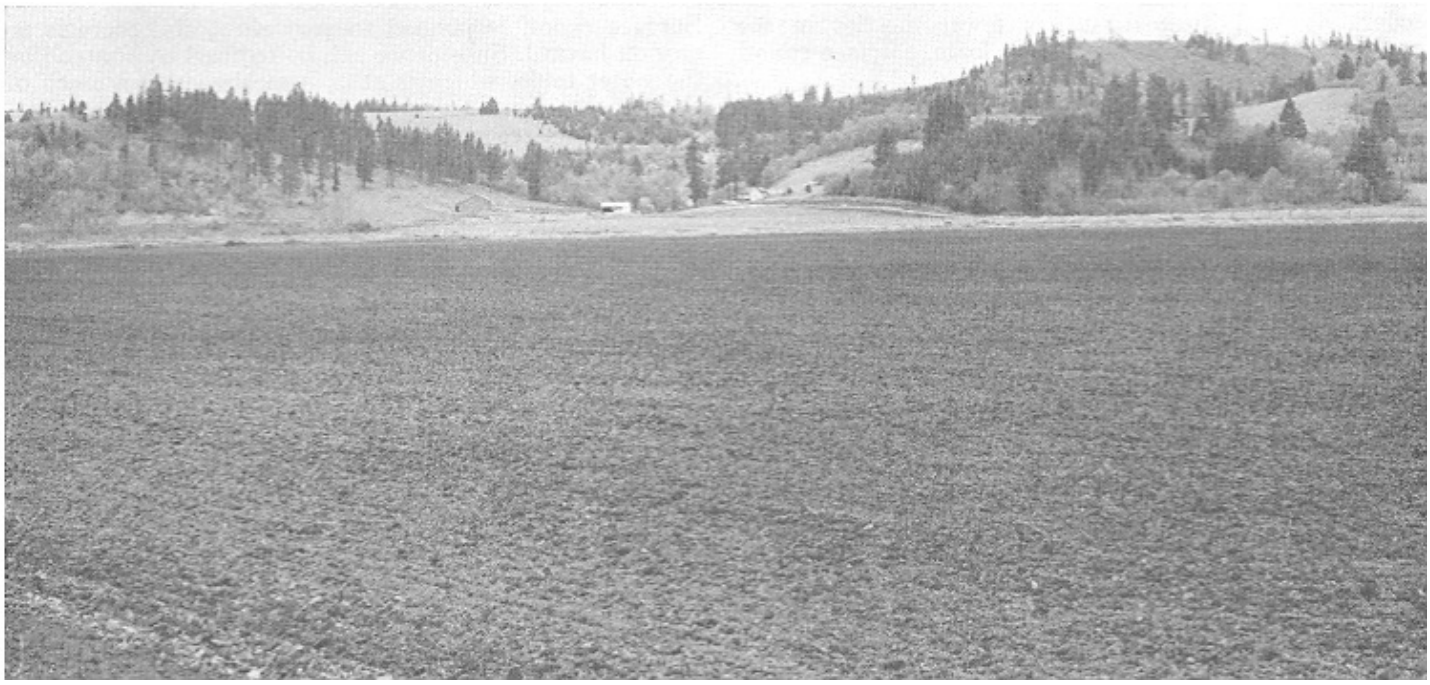

Figure 16.-An area of Semiahmoo muck being prepared for spring planting. This soil is used for peppermint.

Representative profile of Semiahmoo muck, shallow variant, under a cover of mint, southeast corner of sec. 23, T. 5 N., R. 2 E.

Ap-0 to 7 inches, dark reddish-brown (5YR 2/2) muck; weak, fine, granular structure ; slightly hard, friable, nonsticky and nonplastic; many fide roots; strongly acid; abrupt, smooth boundary. (4 to 8 inches thick)

Oa1-7 to 13 inches, dark reddish-brown (5YR 2/2) muck; weak, medium, prismatic structure (apparent when dry) ; slightly hard, friable, nonsticky and nonplastic ; many fine roots ; strongly acid ; abrupt, smooth boundary. (5 to 16 inches thick)

C1-13 to 15 inches, pale-brown (10YR 6/3) fine sand (pumice), very pale brown (10YR 7/4) when dry ; single grain ; soft, very friable, nonstick, and nonplastic ; few fine roots ; strongly acid ; abrupt, smooth boundary. (0 to 2 inches thick)

Oa2-15 to 30 inches, dark reddish-brown (5YR 2/2) muck, dark brown (7.5YR 3/2) when dry ; massive ; soft, friable, nonsticky and nonplastic ; few fine roots ; strongly acid; gradual, wavy boundary. (6 to 15 inches thick)

C2-30 to 60 inches, stratified sand, silt, and clay.

The thickness of the muck over the mineral soil ranges from 15 to 30 inches. The pumice layers range from 1 to 3 inches in thickness.

Peppermint is the principal crop. Establishment of drainage systems and regulation of the water table are necessary before most crops can be grown. Supplemental irrigation is common. (Capability unit IIw-2; wildlife site 5; not assigned to a woodland suitability group)

Sifton Series

The Sifton series consists of somewhat excessively drained, mostly nearly level to gently sloping terrace soils underlain by very gravelly loamy coarse sand or very gravelly coarse sand at a depth of 20 to 30 inches. These are gravelly soils that formed in alluvium deposited by rapidly flowing water. The native prairie vegetation consisted of grasses, ferns, and scattered oaks and Douglas-fir trees. The annual precipitation is 45 inches.

Sifton soils are used mainly for pasture (fig. 17) without supplemental irrigation.

Sifton gravelly loam, 0 to 3 percent slopes (SvA).This soil is on wide terraces.

In a typical profile the surface layer is gravelly loam about 16 inches thick. It is black in the upper part and very dark brown in the lower part. The layer below is very friable, dark-brown very gravelly loamy coarse sand about 8 inches thick. The underlying material, to a depth of 60 inches, is very dark grayish-brown very gravelly coarse sand.

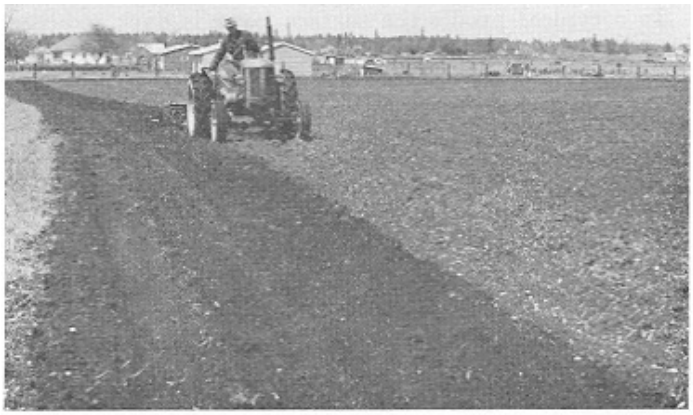

Figure 17.-Seedbed preparation on Sifton gravelly loam, 0 to 3 percent slopes.

Included in mapping were some small areas where gravel makes up less than 15 percent of the surface layer. Also included were a few areas where the slope is more than 5 percent.

This soil is somewhat excessively drained and is rapidly permeable. The available water capacity and fertility are low. Surface runoff is very slow, and there is no erosion hazard.

Representative profile of Sifton gravelly loam in a pasture about 450 feet south of NE. 86th Street and 300 feet west of 94th Avenue, NW1/4SW1/4 sec. 4, T. 2 N., R. 2 E.

Ap-0 to 5 inches, black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) when dry ; weak, fine, granular structure; soft, very friable, slightly sticky and nonplastic; many fine roots; very strongly acid; abrupt, smooth boundary. (4 to 5 inches thick)

A11-5 to 10 inches, black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) when dry ; weak, fine, subangular blocky structure; soft, friable, slightly sticky and nonplastic ; many fine roots ; abundant very fine pores ; strongly acid ; clear, smooth boundary. (4 to 6 inches thick)

A12-10 to 16 inches, very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) when dry; weak, fine and medium, subangular blocky structure; loose, very friable, slightly sticky and slightly plastic ; common fine roots ; plentiful very fine pores ; medium acid; clear, wavy boundary. (4 to 7 inches thick)

IIC1-16 to 24 inches, dark-brown (10YR 3/3) very gravelly loamy coarse sand, brown (10YR 4/3) when dry; massive ; loose, very friable, nonsticky and nonplastic ; few fine roots ; slightly acid ; clear, wavy boundary. (7 to 10 inches thick)

IIC2-24 to 60 inches, very dark grayish-brown (10YR 3/2) very gravelly coarse sand, dark grayish brown (10YR 4/2) when dry ; single grain ; loose, nonsticky and nonplastic ; very few very fine roots ; slightly acid. (Many feet thick)

When this soil is moist, the IIC1 horizon ranges from 10YR to 7.5YR in hue, and from 2 to 3 in chroma. The IIC1 horizon ranges from very gravelly coarse loamy sand to very gravelly sand in texture. The depth to very gravelly coarse sand ranges from about 20 to 30 inches.

Without supplemental irrigation, the low available water capacity limits use of the soil to drought-resistant grasses for pasture. With irrigation, most crops of the area can be grown. (Capability unit IVs-1; wildlife site 11; not assigned to a woodland suitability group)

Tisch Series

The Tisch series consists of deep, poorly drained, highly organic soils underlain by stratified layers of diatomaceous earth and peat to a depth of about 4 feet or more. These are medium-textured soils that formed in alluvium in shallow depressions. They are generally ponded. The relief is level to slightly concave. The original vegetation was sedges, reeds, deciduous trees, hardhack, and other water-tolerant shrubs and grasses. The annual precipitation is 40 to 60 inches.

Tisch soils are used for hay, pasture, mint, and truck crops.

Tisch silt loam, 0 to 3 percent slopes (ThA) -This soil occupies depressions, mainly along Burntbridge Creek. In most places the slope is less than 1 percent.

In a typical profile the surface layer is silt loam about 27 inches thick. It is very dark gray in the upper part and mottled, very dark gray, very dark brown, and pale brown in the lower part. The subsurface layer is very dark brown mottled silt loam about 4 inches thick. The next layer is very dark brown muck about 14 inches thick. The underlying material, to a depth of 53 inches, is very dark grayish-brown peat.

Included in mapping were a few areas where gravel and stones are less than 40 inches below the surface and other areas where the surface layer is silty clay loam. Also included were small areas where thin layers of volcanic ash or diatomite occur within the surface layer.

This soil is poorly drained and is ponded much of the year. Permeability is moderately slow, and fertility is moderate. The available water capacity is very high. There is no erosion hazard. The soil is easily tilled, and drained areas can be cultivated throughout a wide range of moisture content. Artificial drainage is needed to make the soil suitable for farming, but drainage is difficult. Lateral permeability is slow and necessitates closely spaced open or closed drains.

Representative profile of Tisch silt loam, in a pasture about 30 feet north of Burntbridge Creek drainage ditch and 1/8 mile east of NE. 137th Avenue in NE1/4NE1/4NAV1/4 sec. 14, T. 2 N., R. 2 E.

A11-0 to 9 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; weak, fine, subangular blocky structure ; slightly hard, friable, nonsticky and slightly plastic ; many fine and medium roots ; many, very fine, tubular pores ; medium acid ; abrupt, wavy boundary. (8 to 9 inches thick)

A12-9 to 15 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; weak, medium, prismatic structure breaking to weak, medium, angular blocky ; slightly hard, firm, nonsticky and slightly plastic ; many very fine, and common medium, tubular pores ; common, fine, fibrous roots ; layered with diatomite and ash, light brownish gray (10YR 6/2) and white (10YR 8/1) when dry; slightly acid; abrupt, smooth boundary. (5 to 7 inches thick)

A13-15 to 27 inches, laminated, very dark gray (10YR 3/1), very dark brown (10YR 2/2) and pale-brown (10YR 6/3) silt loam, gray (10YR 5/1), grayish brown (10YR 5/2), and white (10YR 8/2) when dry ; few, fine, faint, yellowish-brown mottles ; strong, coarse, prismatic structure breaking to moderate, medium, platy structure ; hard, firm, slightly sticky and slightly plastic ; common fine roots ; many, very fine, tubular pores ; layered diatomite and ash ; slightly acid; abrupt, wavy boundary. (11 to 13 inches thick)

A14-27 to 31 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; few, fine, faint, yellowish-brown mottles ; moderate, coarse, prismatic structure; hard, firm, slightly sticky and slightly plastic; few, fine, fibrous roots ; many, very fine, tubular pores; 15 to 20 percent of this horizon is pale-brown (10YR 6/3) pumice sand; diatomite makes up 50 percent of this horizon; slightly acid ; clear, smooth boundary. (4 to 5 inches thick)

Oa-31 to 45 inches, very dark brown (10YR 2/2) muck, grayish brown (10YR 5/2) when dry; weak, coarse, prismatic structure; slightly hard, friable, nonsticky and nonplastic ; few, fine, fibrous roots ; many, very fine, tubular pores; strongly acid; gradual, wavy boundary. (10 to 18 inches thick)

Oe-45 to 53 inches, very dark grayish-brown (10YR 3/2) mixed fibrous and disintegrated peat, gray (10YR 5/1) and grayish brown (10YR 5/2) when dry; massive; slightly hard, very friable, nonsticky and

nonplastic; no roots; strongly acid. (6 to 12 inches thick)

When the soil is moist, the surface layer ranges from black to very dark gray in color and from light silt loam to heavy silt loam in texture. The underlying material at a depth of more than 40 inches, is gravelly sand, clay, or peat.

Mint, truck crops, hay, and pasture crops are grown. (Capability unit IIw-2 ; wildlife site 5 ; not assigned to a woodland suitability group)

Vader Series

The Vader series consists of well-drained, mostly gently sloping to sloping soils underlain by sandstone. These are medium-textured soils that formed in soft sandstone, probably mixed in the upper part with some volcanic ash. The original vegetation was Douglas-fir, western redcedar, and an understory of vine maple, salal, and ferns. The average annual precipitation is about 50 inches.

These soils are used for hay, pasture, urban development, and timber.

The Vader soils of Clark County are taxadjuncts to the Vader series because many profiles hack a C horizon of loamy sand or sand overlying the sandstone bedrock.

Vader silt loam, 3 to 8 percent slopes (VaB).-This soil is in the Lac auras Lake area. Thee soil is gently undulating, and the slopes are moderate in length.

In a typical profile the surface layer is dark reddish-brown silt loam about 6 inches thick. Shotlike concretions and sandstone fragments make up about 20 to 35 percent of the layer. Below the surface layer is friable, dark reddish-brown loam about 24 inches thick. The underlying material, at a depth of 30 inches, is weathered sandstone bedrock.

Included in mapping were a few areas where the slope is less than 3 percent. Also included were areas where hard sandstone bedrock is at a depth of about 36 inches.

This soil is well drained and moderately rapidly permeable. Roots penetrate to the bedrock. The available water capacity is moderate, and fertility is moderately low. This soil is easily tilled and can be cultivated throughout a wide range of moisture content. Surface runoff is slow, and the hazard of erosion is slight.

Representative profile of Vader silt loam, about 0.3 mile west of road intersection on County Road No. 2, 1 mile north of Camas near Dead Lake, about 1,250 feet south and 750 feet east of northwest corner of sec. 2, T. 1 N., R. 3 E.

O1-3 inches to 1 inch, black (5YR 2/1) mull composed of twigs, needles, and leaves.

O2-1 inch to 0, dark reddish-brown (5YR 2/2) decomposed needles, twigs, ferns, and roots ; dark reddish brown (5YR 3/2) dry; slightly acid.

A11-0 to 1 inch, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/4) dry; moderate, very fine, granular structure ; slightly hard, very friable, slightly sticky and slightly plastic; many roots; about 35 percent of this horizon is shotlike concretions and sandstone fragments ; slightly acid ; abrupt, broken boundary. (1 to 2 inches thick)

A12-1 inch to 6 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/4) dry ; moderate, very fine, granular structure and moderate, very fine, sub angular blocky ; soft, friable, slightly sticky and slightly plastic; many roots; many, very fine, interstitial pores ; about 20 percent of this horizon is shotlike concretions ; medium acid ; clear, wavy boundary. (4 to 6 inches thick)

B21-6 to 18 inches. dark reddish-brown (5YR 3/4) loam, brown (7.5YR 4/4) dry; weak, very fine, subangular blocky structure ; soft, friable, slightly sticky and slightly plastic ; many roots ; common very fine pores ; thin patchy clay films in pores, on sand grains, and on ped faces; medium acid ; gradual, wavy boundary. (9 to 15 inches thick)

B22-18 to 30 inches, dark reddish-brown (5YR 3/4) loam, yellowish red (5YR 4/6) dry; weak, medium, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; common roots ; common fine pores ; thin patchy clay films in pores, on sand grains, and on ped faces ; few soft sandstone fragments ; slightly acid ; abrupt, smooth boundary. (10 to 18 inches thick)

R-30 inches, soft, weathered sandstone bedrock that has many fractures.

This soil is 10 inches shallower to sandstone bedrock than soils within the defined range for the series, but this difference does not alter its usefulness and behavior. Shotlike concretions make up 15 to 40 percent of the A horizon. The thickness of the solum ranges from 24 to 40 inches. A few sandstone fragments, 1/2 inch to 3 inches in diameter, occur at a depth below 18 inches. In some places there is a loamy sand or sand C horizon overlying the sandstone.

Clover and grasses for hay and pasture are the prin cipal crops. Row crops such as corn, beans, and strawberries can be grown, but most of the acreage is in woodland and urban development. (Capability unit IIIe-3 ; woodland suitability group 3dH3 ; wildlife site 6)

Vader silt loam, 8 to 15 percent slopes (VaC).-This soil is along side slopes near the edges of broad ridge tops. It is similar to Vader silt loam, 3 to 8 percent slopes, except that it is steeper and the surface layer is 1 to 3 inches thinner. Surface runoff is medium, and the erosion hazard is moderate. Included in mapping were a few areas where the slope is more than 15 percent.

Clover and grasses for hay and pasture are the prin cipal crops. Row crops such as corn, beans, and strawberries can be grown. Practices such as cross-slope planting are needed to control erosion. (Capability unit IIIe-3; woodland suitability group 3dH3; wildlife site 6)

Washougal Series

The Washougal series consists of somewhat excessively drained, nearly level to very steep soils underlain by sand and gravel at a depth of 26 to 40 inches. These are loamy soils that formed on low terraces in alluvium deposited by swiftly flowing rivers and streams. Most of the material is of volcanic origin. The original vegetation was Douglas-fir, vine maple, dogwood, snowberry, blackberry, grasses, and ferns. The annual precipitation is 50 to 85 inches.

Washougal soils are used for grain, hay, pasture, and forestry.

Washougal gravelly loam, 0 to 8 percent slopes (WgB).-This soil is on gravelly stream terraces along the East Fork of the Lewis, Little Washougal, and Washougal Rivers. It is nearly level except for old, narrow stream channels that formed meandering, depressional troughs.

In a typical profile the surface layer is gravelly loam about 22 inches thick. It is black in the upper part and very dark brown in the lower part. Below the surface

layer is friable, dark-brown very gravelly loam about 8 inches thick. The next laver is dark-brown very gravelly coarse sandy loam about 6 inches thick. The underlying material, to a depth of 60 inches, is brown and gray sand, pebbles, and cobblestones.

Included in mapping were a number of sandy areas that are less than 1 acre in size and are generally along terrace breaks. Also included were small areas that are nongravelly.

This soil is somewhat excessively drained. It is generally moderately permeable, but it is very rapidly permeable in the substratum. The available water capacity is moderate. Roots penetrate to the gravelly sand layer. Tillage is easy, but fertility is low. Surface runoff is slow, and the hazard of erosion is slight. The soil occurs at an elevation high enough in most places to be above the normal high water stages of adjacent rivers.

Representative profile of Washougal gravelly loam, in a wooded area.

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

A11--0 to 5 inches, black (10YR 2/1) gravelly loam, very dark grayish brown (10YR 3/2) when dry; moderate, very fine and medium, granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots ; strongly acid ; clear, smooth boundary. (4 to 6 inches thick)

A12-5 to 14 inches, black (10YR 2/1) gravely loam, very dark grayish brown (10YR 3/2) when dry; weak, very fine and medium, granular structure; soft, very friable, nonsticky and nonplastic ; common fine roots ; strongly acid; gradual, smooth boundary. (8 to 12 inches thick)

A13-14 to 22 inches, very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) when dry; weak, coarse, subangular blocky structure; soft, very friable, nonsticky and nonplastic ; common very fine roots ; strongly acid; abrupt, irregular boundary. (6 to 12 inches thick)

IIC1--22 to 30 inches, dark-brown (7.5YR 3/2) very gravelly loam, brown (7.5YR 4/2) when dry ; massive ; soft, friable, nonsticky and nonplastic ; common very fine roots that flatten out at bottom of horizon; strongly acid ; abrupt, irregular boundary. (6 to 12 inches thick)

IIIC2-30 to 36 inches, dark-brown (10YR 3/3) very gravelly coarse sandy loam, brown (10YR 5/3) when dry ; single grain ; slightly hard, friable, nonsticky and slightly plastic ; few very fine roots ; about 50 percent of this horizon is gravel, and about 25 percent is cobblestones ; intermittent, weak, silica and manganese cementation ; strongly acid ; abrupt, irregular boundary. (4 to 12 inches thick)

IVC3-36 to 60 inches, variegated, mostly brown and gray sand, pebbles, cobblestones, and stones. (Many feet thick)

The A horizon ranges from black (10YR 2/1) to dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2) in color. The depth to very gravelly sand ranges from 26 to 40 inches.

Most of this soil is in second-growth Douglas-fir, but red alder, grand fir, vine maple, and other shrubs fill in. Small tracts have been cleared for hay and pasture. Generally, oats are planted with red clover and ryegrass for hay. Pastures are mixtures of subterranean clover, tall fescue, and ryegrass. Barnyard manure is the common fertilizer. (Capability unit IIIe-3; woodland suitability group 3fM3; wildlife site 6)

Washougal loam, 0 to 3 percent slopes (WaA).-This soil is in the same areas as Washougal gravelly loam, 0 to 8 percent slopes, and is similar to that soil except that the surface layer is free of gravel, and gravelly sand is at a depth of 20 to 36 inches. Included in slapping were a few areas that are deeper. Surface runoff is very slow, and there is no hazard of erosion.

This soil has a higher available water capacity than Washougal gravelly loam, 0 to 8 percent slopes. It is used mainly for forestry, hay, and pasture. (Capability unit IIIs-1; woodland suitability group 3oM0; wildlife site 6)

Washougal gravelly loam, 8 to 30 percent slopes (WgE).-This soil is on terrace fronts along the East Fork of the Lewis and Washougal Rivers. It is similar to Washougal gravelly loam, 0 to 8 percent slopes, except that the surface layer is generally 1 to 2 inches thinner. Surface runoff is moderate to rapid, and the hazard of erosion is moderate to severe if the surface is left bare.

This soil is used almost exclusively for timber. Areas that were formerly cleared have reverted to trees. (Capability unit VIe-2; woodland suitability group 3fM3; wildlife site 6)

Washougal stony loam, 30 to 60 percent slopes (WhF).-This soil is on terrace fronts. The slopes are long. This soil is similar to Washougal gravelly loam, 0 to 8 percent slopes, except it is stony and very steep. Included in mapping were some areas that are gravelly. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare.

The stony surface and the slope limit use mostly to timber. (Capability unit VIe-4; woodland suitability group 4rL5; wildlife site 12)

Wind River Series

The Wind River series consists of deep, somewhat excessively drained, nearly level to very steep soils. These are gravelly soils that formed in Columbia River alluvium of mixed origin. They occur at elevations of 150 to 500 feet, in the southwestern part of the county, between Vancouver and Orchards. The original vegetation was Douglas-fir, grand fir, and Oregon white oak. The understory was hazel, dogwood, vine maple, salal, and ferns. The annual precipitation is about 40 inches.

Nearly all the acreage has been cleared and cultivated. It is rapidly being converted to urban development. The few areas in crop production are used mainly for pasture, tree fruits, nuts, and row crops.

Wind River sandy loam, 0 to 8 percent slopes (WnB).-This is the dominant soil in the northwestern part of Vancouver and in the Hazel Dell area.

In a typical profile the surface layer is dark reddish-brown sandy loam about 8 inches thick. Below the surface layer is very friable, dark reddish-brown coarse sandy loam about 16 inches thick. The next layer is very dark grayish-brown loamy coarse sand about 28 inches thick. The next layer is very dark grayish-brown loamy coarse sand about 28 inches thick. The underlying material, to a depth of 62 inches, is multicolored coarse sand.

This soil is somewhat excessively drained and easily tilled. Permeability is moderately rapid in the upper part of the soil, but water tends to perch above a depth

of 24 inches, apparently as a result of differences in moisture tension between the two lavers. Permeability is rapid in the substratum. The available water capacity and fertility are moderate. Surface runoff is slow, and the hazard of erosion is slight.

Representative profile of Wind River sandy loam, in woodland near Lincoln Avenue and 51st Street, beneath power transmission lines, about 400 feet, west and 300 feet south of northeast corner of sec. 16, T. 2 N., R. 1 E.

O1-1 to 1/2 inch, leaves, grass, and decaying fern.

O2-1/2 inch to 0, very dark brown (10YR 2/2) decomposed organic material; abrupt, smooth boundary.

A1-0 to 4 inches, dark reddish-brown (5YR 2/2) sandy loam, dark reddish brown (5YR 3/2) when dry; weak, very fine, granular structure; sligh1y hard, very friable, nonsticky and nonplastic; many fine and medium roots ; slightly acid ; abrupt, wavy boundary. (2 to 6 inches thick)

A3-4 to 8 inches, dark reddish-brown (5YR 3/2) coarse sandy loam, brown or dark brown (7.5YR 4/4) when dry ; weak, fine, granular structure ; slightly hard, very friable, nonsticky and nonplastic; many fine and medium roots ; neutral ; clear, wavy boundary. (3 to 5 inches thick)

B2-8 to 24 inches, dark reddish-brown (5YR 3/3) coarse sandy loam, reddish brown (7.5YR 5/4) when dry; weak, fine, subangular blocky structure ; slightly hard, very friable, nonsticky and nonplastic ; common, fine and medium, fibrous roots ; neutral ; abrupt, irregular boundary. (12 to 20 inches thick)

C1-24 to 52 inches, very dark grayish-brown (10YR 3/2) loamy coarse sand, yellowish brown (10YR 5/4) when dry; massive ; slightly hard, firm in place, nonsticky and nonplastic; no roots; neutral; abrupt, smooth boundary. (16 to 32 inches thick)

C2-52 to 62 inches, multicolored, dark- and light-colored coarse sand; single grain; loose, nonsticky and nonplastic; neutral. (Many feet thick)

The B2 horizon ranges from coarse sandy loam to sandy loam in texture, and from dark brown to dark reddish brown in color. A few fine pebbles occur throughout the profile. The uppermost part of the C horizon is commonly loamy coarse sand, or loamy sand that grades to coarse sand at depths ranging from 40 inches to 6 feet. In places the uppermost part of the C horizon has a slightly hard or hard consistence and is brittle when the soil is dry.

Most of this soil is used for residential developments, but a few acres are still in cultivation. Tree fruits, nuts, small grains, and truck crops are common crops. Grasses, grains, and row crops respond to nitrogen. "Equipment pans" or "tillage pans" tend to develop directly below the plow layer after the soil is cultivated for a number of years. Use of subsoilers or deep plowing helps to correct this condition. (Capability unit IIIe-3; woodland suitability group 4sH2; wildlife site 6)

Wind River gravelly loam, 0 to 8 percent slopes (WrB).-This is the dominant soil in the area between Vancouver and Orchards. In most places the slope is nearly level and is generally less than 3 percent. It is similar to Wind River sandy loam, 0 to f percent slopes, except for the texture of the surface layer.

Nearly all of this soil has been cleared and is in cultivation or suburban development. The principal crops are pasture, tree fruits, and row crops. Red clover and white clover are the legumes commonly grown; orchardgrass, tall fescue, and ryegrass are the common grasses. Pears, apples, and hazelnuts are the tree crops; pole beans and strawberries are the common row crops. (Capability unit IIIe-3; woodland suitability group 3fM3; wildlife site 6)

Wind River sandy loam, 8 to 20 percent slopes (WnD).-This soil is similar to Wind River sandy loam, 0 to 8 percent slopes, except that it is steeper and the surface layer in most places is 1 to 2 inches thinner. Surface runoff is medium, and the hazard of erosion is moderate if the surface is left bare.

Tree fruits, nuts, small grains, and truck crops can be grown, but cross-slope tillage is needed to control erosion. Most of the acreage is used for residential development or woodland. This is a good soil for Douglas-fir. (Capability unit IVe-1; woodland suitability group 4sH2 ; wildlife site 6)

Wind River sandy loam, 30 to 65 percent slopes (WnG).-This soil is similar to Wind River sandy loam, 0 to 8 percent slopes, except that the surface layer is 2 to 4 inches thinner. This soil is on slopes that lead into drainageways and streams. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare in winter.

This soil is too steep for cultivation and is better suited to timber than to other uses. (Capability unit VIe-5; woodland suitability group 4rL5; wildlife site 6)

Wind River gravelly loam, 12 to 50 percent slopes (WrF).-This soil is similar to Wind River sandy loam, 0 to 8 percent slopes, except that 15 to 50 percent of it is gravel, and the surface layer is generally 1 to 2 inches thinner. Included in mapping were a few areas where gravel makes up more than 50 percent of the soil. In most places the slopes are short and along the edge of terraces. Surface runoff is medium to very rapid, and the hazard of erosion is moderate to very severe.

Much of the acreage is in suburban development. Where it is still under cultivation, pasture is grown. Cross-slope or contour tillage is needed to help control runoff and erosion. (Capability unit VIe-5; woodland suitability group 3rM4; wildlife site 6)

Yacolt Series

The Yacolt series consists of deep, well-drained, nearly level to sloping soils on terraces along streams in uplands and mountainous terrain. These are medium-textured soils that formed in glacial alluvium that consisted largely of pumice, basalt, and volcanic ash. The original vegetation was Douglas-fir, grand fir, hemlock, vine maple, salal, and ferns. The annual precipitation is about 85 inches.

Yacolt soils are used mainly for woodland; some small areas are cleared and used for grain, hay, and pasture.

Yacolt loam, 3 to 15 percent slopes (YaC).-This soil is on broad, undulating terraces along upland and mountain streams, such as Cedar Creek, Rock Creek, and Big Tree Creek in the northeastern part of Clark County. Most of the slopes are short and complex, except on terrace fronts, where they are short and smooth. On the terraces the slopes are generally about 3 to 5 percent; between the terraces they are about 12 to 15 percent.

In a typical profile the surface layer is very dark brown in color and about 23 inches in thickness. It is loam in the upper part, and gravelly loam in the lower

part. Below the surface layer is gravelly loam about 16 inches thick. It is firm and dark brown in the upper part and friable and dark yellowish brown in the lower part. The next layer, to a depth of 61 inches, is Clark-brown cobbly loam.

Included in mapping were a few small areas where the surface layer is silt loam.

This soil is well drained and moderately permeable. Tillage is easy. The available water capacity is moderately high, and fertility is moderately low. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

Representative profile of Yacolt loam, in woodland near Rock Creek, about 150 feet north of gravel storage pit on property of State Department of Natural Resources; about 2,000 feet north and 550 feet west of southeast corner of sec. 5, T. 3 N., R. 4 E.

A11-0 to 6 inches, very dark brown (10YR 2/2) loam, brown (10YR 4/3) when dry ; moderate, fine and very fine, granular structure ; slightly hard, very friable, nonsticky and nonplastic ; many fine, medium, and large roots ; about 20 percent of this horizon is shotlike concretions ; medium acid; clear, smooth boundary. (4 to 7 inches thick)

A12-6 to 15 inches, very dark brown (10YR, 2/2) loam, brown (10YR 4/3) when dry ; moderate, fine and medium, granular structure; soft, friable, nonsticky and nonplastic ; many fine, medium, and large roots ; about 20 percent of this horizon is shotlike concretions ; medium acid; gradual, wavy boundary. (5 to 11 inches thick)

A13-15 to 23 inches, very dark brown (10YR 2/2) gravelly loam, brown (10YR 4/3) when dry; moderate, medium, granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine, medium, and large roots ; medium acid; clear, wary boundary. (5 to 10 inches thick)

B21-23 to 30 inches, dark-brown (10YR 3/3) gravelly loam, yellowish brown (10YR 5/4) when dry ; moderate, fine, subangular blocky structure ; slightly hard, firm, slightly sticky and slightly plastic; common fine and medium roots ; common, very fine, tubular pores ; medium acid ; clear, wavy boundary. (5 to 9 inches thick)

B22-30 to 39 inches, dark yellowish-brown (10YR 4/4) gravelly loam, pale brown (10YR 6/3) when dry; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine fibrous roots ; common, very fine, tabular pores ; few, fine, prominent, black (N 2/0) manganese stains; medium acid; gradual, wavy boundary. (7 to 12 inches thick)

C-39 to 61 inches, dark-brown (7.5YR 4/4) cobbly loam, light yellowish brown (10YR 6/4) when dry; common, medium, faint, strong-brown (7.51R 5/6) mottles ; massive; slightly hard, friable, slightly sticky and slightly plastic ; few fine fibrous roots ; few, very fine, tubular pores ; medium acid.

The shotlike concretions are composed of iron-manganese concretions and weathered pumice fragments up to a quarter of an inch in diameter. Shotlike concretions make up 15 to 35 percent of the A horizon. The B horizon is composed of 20 to 50 percent basalt and andesite gravel, cobblestones, and stones.

The short growing season, high rainfall, and remote location of this soil limit its use mainly to woodland and wildlife habitat. Some areas are cleared, however, and used for grain, hay, and pasture. Seedbed preparation is difficult because of the fluffy soil condition. Fescue grasses, subterranean clover, red clover, and white clover are used in mixtures. (Capability trait IIIe-2; woodland suitability group 3oH3; wildlife site 8)

Yacolt loam, 0 to 3 percent slopes (YaA).-This soil is in the same areas as Yacolt loam, 3 to 15 percent slopes. It is similar to that soil, except that it is nearly level. Surface runoff is very slow, and there is no erosion hazard.

This soil is used for the same crops as Yacolt loam, 3 to 15 percent slopes, except that a larger acreage is cleared and used for grain, hay, and pasture. (Capability unit IIIs-1; woodland suitability group 3oH3 ; wildlife site 8)

Yacolt stony loam, 0 to 5 percent slopes (YcB).-This soil is closely associated with Yacolt loam, 3 to 15 percent slopes, and is similar to that soil except that the surface layer is stony and the slopes are less steep. Surface runoff is slow, and the erosion hazard is none to slight.

Stoniness limits the use of this soil mainly to forestry and unimproved pasture. (Capability unit VIs-1; woodland suitability group 3oH3; wildlife site 12)

Use and Management of the Soils

This section gives an explanation of the capability classification system and descriptions of the individual capability units. It also contains a table of estimated yields and a brief discussion of the management required to obtain the yields. In addition, this section discusses the use of the soils of Clark County for woodland, wildlife, engineering, and nonfarm purposes.

Capability Grouping

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

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, woodland, or wildlife habitat. (None in this county)

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

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

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation ; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

The names of the soil series represented are mentioned in the description of each capability unit, but the listing of the series name does not necessarily mean that all the soils of a series are in the same capability unit. The capability classification of any given soil can be learned by referring to the "Guide to Mapping Units."

In the following pages the capability units in Clark County are described, and suggestions for the use and management of the soils are given.

CAPABILITY UNIT I-1

This unit consists of deep, well-drained, nearly level, alluvial soils of the Cloquato and Newberg series.

Fertility and the organic-matter content are high. The available water capacity is high, and permeability is moderate or moderately rapid. Surface runoff is very slow, and there is little or no hazard of erosion.

The soils in this unit are generally suited to all the crops that are adapted to the climate and that require good drainage. Row crops and forage crops, along with grain, tree fruits, and pasture, are grown.

Sprinkler irrigation is beneficial to row crops and to hay and pasture. Sprinkler, furrow, or border irrigation can be used. Sprinkler irrigation, the most popular method, requires the least soil preparation before installation. Land leveling is accomplished with little difficulty and can be done with only slight damage to the soils. Sources of irrigation water are adjacent streams or shallow wells. In areas where diking is needed to protect from overflow, minimum drainage is also needed to carry off excess water that collects from seepage or rainfall.

Row crops respond well to application of nitrogen, phosphorus, and potassium. Lime and minor elements are not necessary for satisfactory crop production. The organic-matter content can be maintained by returning all crop residue to the soil and by including green-manure crops in the cropping system.

CAPABILITY UNIT I-2

This unit consists of deep, well-drained soils of the Hillsboro series. These are nearly level soils on terraces.

Fertility is high. The available water capacity is high or very high, and permeability is moderate. Surface runoff is very slow, and the hazard of erosion is none to slight.

The soils in this unit are generally suited to all the crops that are adapted to the climate and that require good drainage. Sprinkler irrigation is beneficial to row crops and to hay and pasture. Many crops, such as tree fruits, cane fruits, nuts, grain, potatoes, and hay, are grown without irrigation. Sources of water are wells 100 to 250 feet deep.

Nonleguminous crops respond well to nitrogen. Alfalfa responds well to applications of agricultural borax and phosphorus. Pear trees are susceptible to boron deficiency. Under a high level of management, irrigated crops respond to applications of potassium.

The organic-matter content can be maintained by returning all crop residue to the soil and by using green-manure crops in the cropping systems. Cropping systems that include hay and pasture are advisable. Irrigated and fertilized pastures that are grazed in rotation produce maximum amounts of forage.

Excessive cultivation when the soils are wet results in formation of tillage pans. Such pans are common. Care must be taken to vary the depth of tillage so that the pans are broken up.

CAPABILITY UNIT IIe-1

This unit consists of deep, well-drained soils of the Hillsboro series. These are gently sloping soils on terraces.

Fertility is moderately high. The available water capacity is high to very high, and permeability is moderate. Surface runoff is slow, and the hazard of erosion is slight.

The soils in this unit are normally productive, but conservation practices are needed to maintain fertility and offset the erosion hazard. Planting across the slope and rough plowing reduce the hazard of erosion. A winter cover crop or green-manure crop is advisable in areas that would otherwise be bare during the rainy season. Crops respond well to sprinkler irrigation. Pole beans, strawberries, sweet corn, and other row crops are grown under irrigation. Such crops as tree fruits, cane fruits, corn for silage, grain, potatoes, and hay and pasture are produced without supplemental irrigation.

Most crops respond to applications of phosphorus. Nonleguminous crops respond well to nitrogen. Alfalfa responds well to agricultural borax. Tree fruits, such as pears, are susceptible to boron deficiency on these soils. Irrigated pasture responds to applications of potassium. Liming has not proved beneficial.

The organic-matter content can be maintained by utilizing all crop residue, green-manure crops, and cover crops. Cropping systems should include hay and pasture and green-manure crops. A typical cropping system includes 2 to 3 years of red clover and grass, 2 to 3 years of row crops, and such winter cover crops as rye for soil protection. Excessive cultivation while the soils are wet results in formation of tillage pans.

CAPABILITY UNIT IIe-2

This unit consists of deep, well drained and moderately well drained, alluvial soils of the Newberg and Sauvie series. These are gently sloping soils of the bottom lands. They are on the side slopes of low natural levees along the Columbia River. In most areas they have short slopes that are generally less than 200 feet long.

Fertility is high. The available water capacity is high, and permeability is moderately rapid and moderately slow. Surface runoff is slow, and there is a slight hazard of erosion.

These soils are productive, but conservation practices are needed to control erosion. Tillage across the slope, use of winter cover crops, and rough plowing are needed to check soil loss. Farming across the slope is easily done because most fields run parallel to the natural levees.

Row crops, forage crops, grain, and tree fruits are grown. They respond well to sprinkler irrigation.

Most crops respond to applications of phosphorus. Nonleguminous crops respond well to nitrogen. Use of minor elements or lime is not needed for satisfactory crop production.

To maintain organic-matter content, all crop residue should be returned to the soil. It is advisable to plant cover crops or green-manure crops for protection during the rainy season. Cropping systems should include soil-improving crops, such as hay and pasture. A typical cropping system includes 4 to 6 years of Alfalfa and orchardgrass, followed by 4 to 6 years of row crops or grain. Winter cover crops should be included for soil protection and maintenance of organic-matter content.

CAPABILITY UNIT IIe-3

Cinebar silt loam, 3 to 8 percent slopes, is the only soil in this unit. This is a deep, well-drained soil on terraces and uplands.

Fertility is moderate. The available water capacity is very high, and permeability is moderate. Surface runoff is slow, and the hazard of erosion is slight.

This soil is productive if properly managed. Hay and pasture are the common crops, but such crops as strawberries, caneberries, nuts, and grain are also produced.

Most crops respond well to applications of phosphorus. Nonleguminous crops respond well to nitrogen. Applications of lime are beneficial if followed by a commercial fertilizer, especially in fields that are sprinkler irrigated.

Cropping systems should include such crops as hay or pasture. A suitable cropping system is 3 years of red clover and ryegrass, followed by 2 years of grain or row crops. Winter cover crops should be included to protect the soil and maintain the organic-matter content.

CAPABILITY UNIT IIe-4

This unit consists of deep, well-drained soils of the Hesson and Olympic series. These are mainly gently sloping soils on terraces and uplands.

Fertility is moderate. The available water capacity is moderately high or high, and permeability is moderately slow. Surface runoff is slow, and there is a slight hazard of erosion.

These soils are productive, but conservation practices are needed to maintain fertility and offset the erosion hazard. A winter cover crop or green-manure crop is advisable in areas that would otherwise be bare during the rainy season. Cross-slope planting, cultivation, and rough plowing reduce the hazard of erosion.

Suitable crops are tree fruits, corn for silage, strawberries, and hay and pasture. Suitable legumes are trefoil, red clover, subterranean clover, and Ladino clover. Suitable grasses include tall fescue and orchardgrass. Supplemental irrigation and proper fertilization are needed.

Nonleguminous crops respond to nitrogen. Legumes respond to phosphorus and lime. Application of lime is important in the establishment of legumes. Cropping systems should include such crops as hay and pasture. A suitable cropping system is legume-grass hay for 3 years, followed by row crops or grain for 2 years.

CAPABILITY UNIT IIw-1

This unit consists of deep, moderately well drained and somewhat poorly drained, alluvial soils of the McBee and Sauvie series. These are nearly level soils. McBee soils are subject to seasonal wetness, and Sauvie soils are subject to flooding.

Fertility is moderate or high. The available water capacity is very high, and permeability is moderately slow. Surface runoff is very slow or ponded, and the hazard of erosion is none to slight.

If drained, McBee soils can produce a wide variety of crops. Row crops, grain, and hay and pasture are the

general crops. If not drained, McBee soils are limited generally to water-tolerant forage crops. Sauvie soils can be used for most crops. Open drains or tile drainage can be used to increase the range of suitability of the soils for crops.

Forage crops and row crops respond well to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Little data is available on the need for minor elements. Returning crop residue to the soil and using green-manure crops in the cropping systems help to maintain the organic-matter content.

In diked and drained areas, irrigation is a substantial benefit to crops. Sprinkler irrigation is the common method of applying irrigation water. Tae' source of the water is generally an adjacent river or stream. Tillage pans are common, and consequently, care must be taken to avoid cultivation when these soils are wet.

CAPABILITY UNIT IIw-2

This unit consists of poorly drained and very poorly drained, organic soils of the Semiahmoo and Tisch series. These are nearly level and depressional soils on uplands and in stream valleys. These soils are subject to flooding and seasonal wetness.

Fertility is low to moderate. The available water capacity is very high. Permeability is moderate to moderately slow. Surface runoff is very slow to ponded, and there is no erosion hazard. Subsidence is excessive unless the water table is controlled and maintained near the surface.

These soils require drainage before they can be used for crops. A complete system of open ditches and box drains that have a means of controlling the water table should be installed. Specialty crops, such as peppermint, lettuce, bulbs, onions, carrots, and dill, are grown in drained areas. Some water-tolerant forage crops can be grown in undrained areas.

Deep tillage may be needed occasionally to break up tillage pans. Under intensive management, lime is needed and a balanced fertilizer program that includes nitrogen, phosphorus, potash, and minor elements is required. Supplemental irrigation is needed where the water table cannot be maintained at a height sufficient to maintain moisture in the root zone.

CAPABILITY UNIT IIIe-1

This unit consists of deep, well-drained to somewhat poorly drained, gently sloping to moderately steep soils of the Gee, Hessen, Olequa, Olympic, Powell, Salkum, and Sara series. These soils occur on terraces and uplands.

Fertility is low to moderately high. The available water capacity is moderately high to very high. Permeability is moderate to very slow. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

These are moderately productive soils, but care must be taken to control soil loss in cropped fields. Conservation practices are necessary to maintain fertility and check erosion. Cross-slope planting, cultivation, and rough plowing substantially help to reduce erosion. Winter cover crops that protect bare areas during the rainy season are beneficial.

Crops respond well to sprinkler irrigation. Pole beans, cucumbers, sweet corn, and other row crops can be grown under irrigation. Such crops as strawberries, cane fruits, tree fruits, corn for silage, grain, hay, and pasture can be grown without irrigation.

Most crops respond to phosphorus. Nonleguminous crops respond well to nitrogen. Alfalfa responds to agricultural lime and borax. Tree fruits, such as pears, are susceptible to boron deficiency. Irrigated crops, such as pasture, respond to application of potassium.

Cropping systems should include soil-improving crops, such as hay or pasture. A suitable cropping system is alfalfa-grass hay for 5 to 7 years, followed by row crops or grain for 2 to 3 years. The organic-matter content can be maintained by utilizing all crop residue and growing green-manure and cover crops.

CAPABILITY UNIT IIIe-2

This unit consists of deep, well drained and moderately well drained soils of the Bear Prairie, Cinebar, Mossyrock, and Yacolt series. These are nearly level to moderately steep soils on terraces, uplands, and mountain foot slopes.

Fertility is low to moderate. The available water capacity is moderately high to very high. Permeability is moderate. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

The soils in this unit are used for timber, hay, and pasture. All tillage should be across the slope or on the contour. Ground cover is needed in winter to reduce erosion loss. Large amounts of fertilizer are needed. Hay and pasture respond well to fertilization. Cropping systems should include soil-improving crops, such as hay, pasture, and green-manure crops. A typical cropping system consists of red clover and ryegrass for 2 or 3 years, followed by grain for 1 or 2 years.

The hay and pasture respond well to sprinkler irrigation. In the areas near Bear Prairie and Skye, sources of irrigation water are limited, but in the Chelatchie Valley, shallow wells and creeks are good sources of irrigation water.

CAPABILITY UNIT IIIe-3

This unit consists of moderately deep and deep, well-drained to somewhat excessively drained soils of the Lauren, Vader, Washougal, and Wind River series. These soils are nearly level to strongly sloping. They occur on terraces.

Fertility is moderately low to moderate. The available water capacity is moderate. Permeability is generally moderately rapid, but it is rapid in the substratum of the Lauren, Washougal, and Wind River soils. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Urban expansion of nearby Vancouver and Camas is encroaching upon the farm uses of the soils of this capability unit. Areas still in farmland are used for hay, pasture, grain, and a few orchards. Some crops, such as pole beans, cucumbers, strawberries, pasture, and alfalfa for hay, are sprinkler irrigated.

All crops, including legumes, respond to phosphorus. Crops also respond well to mixtures of lime and fertilizer. Nonleguminous crops respond to nitrogen.

The supply of organic matter can be maintained by returning crop residue to the soil and by using green-manure crops in the cropping system. The cropping system should include soil-improving crops, such as pasture or hay. An example of a suitable cropping system consists of 3 years of red clover and ryegrass, follower- by 2 years of grain. Irrigation water is generally obtained from drilled wells 50 to 200 feet deep.

CAPABILITY UNIT IIIe-4

This unit consists of deep, moderately well drained soils of the Dollar, Gee, Hockinson, Powell, and Sara series. These are gently sloping soils on terraces.

Fertility is moderate. The available water capacity is high to moderate. Permeability is slow and very slow. Surface runoff is slow, and the hazard of erosion is slight.

Under good management, these soils are productive. Such practices as tiling wet areas, farming across the slope, and including green-manure and cover crops, cropping systems, and fertilization care needed for soil protection. Crops respond well to sprinkler irrigation. Pole beans, cucumbers, sweet corn, and other row crops are grown under irrigation. Such crops as strawberries, cane fruits, corn for silage, grain, potatoes, hay, and pasture are grown without supplemental irrigation. Maximum forage yields are obtained from irrigated pasture if the pasture is fertilized and is grazed in rotation.

The organic-matter content can be maintained by utilizing all crop residue, growing green-manure crops, and using suitable cropping systems. Cropping systems should include soil-improving crops, such as hay or pasture. A suitable cropping system includes pasture of white clover, orchardgrass, and ryegrass for 4 to 6 years, followed by strawberries for 3 to 4 years.

Most crops respond to phosphorus and potassium. Under intensive management, irrigated crops respond to additional applications of potassium. Nor leguminous crops respond well to nitrogen. Legumes benefit from application of agricultural lime.

CAPABILITY UNIT IIIe-5

This unit consists of deep, well-drained soils of the Hillsboro series. These are sloping to moderately steep soils on terraces.

Fertility is moderately high. The available water capacity is high and very high. Permeability is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

Under good management, these soils are very productive. Such practices as farming across the slope, growing green-manure and cover crops, crop rotation, and fertilization are needed for soil protection and productivity.

The main crops are tree fruits, nuts, grain, hay, and pasture.

Nonleguminous crops respond to nitrogen. Alfalfa responds to phosphorus. Pear trees are susceptible to boron deficiency. Under a high level of management, irrigated crops respond to applications of potassium.

The organic-matter content can be maintained by utilizing all crop residue, growing green-manure crops, and using suitable cropping systems. Cropping systems that include hay or pasture are beneficial. A suitable system includes 4 years of alfalfa-grass mixture, followed by 2 years of grain.

CAPABILITY UNIT IIIw-1

This unit consists of deep, somewhat poorly drained and moderately well drained soils of the Dollar, Hockinson, and McBee series. These are nearly level soils on terraces. They are subject to wetness, and, in places, flooding.

Fertility is moderate. The available water capacity is moderately high to high. Permeability is moderate to very slow. Surface runoff is very slow, and there is no erosion hazard.

These soils are not highly productive, even after drainage. They lack adequate soil depth and sufficient available water capacity to carry crops through the dry summer. Supplemental irrigation and drainage are necessary before an improved cropping system can be used. Open drains generally are more satisfactory than other drainage methods. Tile drainage generally is not feasible for the McBee soils, because of the inadequate soil depth and the very slow, lateral internal drainage. Drained areas are suited to hay, pasture, and grain. Undrained areas are limited to water-tolerant crops. Under sprinkler irrigation, annual row crops can be grown.

If the soils are drained, forage and other crops respond well to nitrogen, phosphorus, and potassium. Returning all crop residue to the soil and growing green-manure crops help to maintain the organic-matter content. A typical cropping system includes pasture of white clover, tall fescue, and ryegrass for 6 to 8 years, followed by grain or row crops for 1 or 2 years.

Sprinkler irrigation is the common method of applying irrigation water. The sources of water are drilled wells, 150 to 200 feet deep, or irrigation ponds.

CAPABILITY UNIT IIIs-1

This unit consists of deep, well-drained and somewhat excessively drained soils of the Puyallup, Washougal, and Yacolt series. These are nearly level soils on bottom lands and terraces.

Fertility is low to moderate. The available water capacity is moderate to moderately high. Permeability is moderate to rapid. Surface runoff is very slow, and there is no erosion hazard, except in a few places on the Puyallup soils that are subject to flooding.

The soils tend to be somewhat droughty. If irrigation is used, a wider variety of crops can be grown. Pole beans, cucumbers, corn, and high-yielding pasture can be grown under irrigation. Hay, pasture, grain, and corn for silage are the common crops grown without irrigation.

Crops respond well to nitrogen, phosphorus, and potassium. The organic-matter content can be maintained by returning all crop residue to the soil and by including green-manure crops in the cropping system. A suitable cropping system consists of 5 to 6 years of white clover and perennial grasses, followed by 2 to 3 years of grain or row crops and a green-manure crop.

Pasture of long-lived white clover and orchardgrass is well suited, but the pasture should be irrigated and fertilized. The sources of water are shallow wells, sumps, or nearby streams.

CAPABILITY UNIT IVe-1

This unit consists of deep, somewhat excessively drained soils of the Lauren and Wind River series. These are nearly level to moderately steep soils on terraces.

Fertility and the available water capacity are moderate. Permeability is generally moderately rapid, but it is rapid in the substratum. Surface runoff is slow to medium, and the erosion hazard is slight to moderate.

The farming use of these soils is rapidly being encroached upon by the urban expansion_ of Vancouver. Areas remaining in farms are used mainly for hay and pasture. A small acreage is sprinkler irrigated.

Nonleguminous crops respond to nitrogen. Legumes respond to phosphorus. Crop response to liming and fertilization is good.

The supply of organic matter can be maintained by returning all crop residue to the soil, by using cover crops in orchards, and by including green-manure crops in the cropping systems. All crops should be tilled across the slope or on the contour to reduce soil loss. A typical cropping system includes pasture of tall fescue and subterranean clover for 6 to 7 years, followed by grain as a cleanup crop for 1 to 2 years. The source of water for sprinkler irrigation is drilled wells, 50 to 200 feet in depth.

CAPABILITY UNIT IVe-2

This unit consists of deep, well drained and moderately well drained soils of the Hillsboro series. These are moderately steep soils on terraces.

Fertility is moderately high. The available water capacity is high or very high. Permeability is moderate. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe.

Tillage should be across the slope or on the contour. The choice of crops is reduced because of the slope and the erosion hazard. Hay and pasture are the common crops, but some grain, strawberries and other fruits, and nuts are also grown.

Nearly all crops respond to applications of phosphorus. Liming is beneficial to all crops. Nonleguminous crops respond to nitrogen.

Cover crops should be used for soil protection in winter and for maintenance of organic-matter content. A suitable cropping system is 5 to 7 years of subterranean clover and fescue grasses, followed by l to 2 years of grain or row crops. Winter cover crops should be included for soil protection.

CAPABILITY UNIT IVe-3

This unit consists of moderately deep and deep, and moderately well drained and well drained soils of the Kinney, Lauren, and Olympic series. These soils are sloping and moderately steep on terraces and mountain foot slopes.

Fertility is low to moderate, and the available water capacity is moderate to high. Permeability is moderate to very slow. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

These soils have slopes that limit their use mainly to long-lived grasses and legumes for hay and pasture. Cultivated crops are needed as a part of a cleanup program before reestablishing long-lived hay or pasture.

All crops respond to nitrogen. Most crops respond to phosphorus. The use of lime with the fertilizer is beneficial. All tillage should be on the contour or across the slope. Winter cover crops in orchards check runoff and lessen the erosion hazard. An example of a suitable cropping system is 6 to 8 years of birdsfoot trefoil and orchardgrass. followed by 1 to 2 years of grain as a cleanup crop.

CAPABILITY UNIT IVe-4

This unit consists of deep, well drained and moderately well drained soils of the Cinebar, Gee, Hesson, Olequa, Olympic, and Powell series. These are moderately steep soils on terraces and uplands.

Fertility is moderate to moderately high. The available water capacity is moderate to very high. Permeability is moderate to very slow. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe.

These soils are moderately productive, but extreme care must be taken to control soil loss in cropped fields. Conservation practices are needed to maintain fertility and to reduce soil loss. Cross-slope planting, cultivation, and rough plowing are needed to control erosion. Winter cover crops help to protect bare areas during the rainy season.

The common crops are oats, hay, and pasture. Some tree fruits and nuts can be grown. The common grasses and legumes are red clover, New Zealand white clover, birdsfoot trefoil, orchardgrass, tall fescue, and ryegrass.

All crops respond to nitrogen. Phosphorus and lime are also beneficial. Vegetative cover is needed in winter to check runoff and control erosion.

A suitable cropping system includes 6 to 8 years of birdsfoot trefoil and orchardgrass, followed by 1 or 2 years of grain.

CAPABILITY UNIT IVw-1

This unit consists of deep, poorly drained soils of the Cove, Gumboot, Minniece, and Odne series. These are nearly level and gently sloping soils that occur in drainageways. The Minniece soils have a cemented pan at a depth of about 22 inches. The other soils have a silty clay loam to clay subsoil.

Fertility is low to moderate. The available water capacity is low to moderately high. Permeability is very slow. There is a seasonal high water table in winter and spring. Surface runoff is slow to very slow, and there is no erosion hazard.

The high rainfall, the short growing season, and inaccessibility limit the use of these soils. In areas where open surface drains are provided, these soils are suited to hay and pasture.

Grasses and legumes respond to nitrogen and phosphorus. A typical cropping system includes pasture of trefoil, white clover, tall fescue, and ryegrass for 6 to 8 years, followed by a cleanup crop of 1 to 2 years of grain or corn for silage.

CAPABILITY UNIT IVs-1

Sifton gravelly loam, 0 to 3 percent slopes, is the only soil in this unit. This is a somewhat excessively drained soil on terraces.

Fertility and the available water capacity are low. Permeability is very rapid. Surface runoff is very slow, and there is no erosion hazard.

If unirrigated, this droughty soil is better suited to hay or pasture than to other uses. Without supplemental irrigation, only drought-resistant crops should be grown because the available water capacity is not sufficient to carry crops through the dry periods of summer.

Crops respond well to nitrogen and phosphorus. To insure maximum crop benefits, fertilizer should be applied late in winter or early in spring at the time of optimum soil moisture. A suitable cropping system is 6 to 8 years of tall fescue and subterranean clover, followed by 1 to 2 years of grain as a cleanup crop.

The use of sprinkler irrigation permits a wider selection of crops. Row crops, cane fruits, and excellent pasture and hay mixtures can be grown under irrigation. Sources of irrigation water are wells 10 to 150 feet deep.

CAPABILITY UNIT Vw-1

This unit consists of poorly drained and very poorly drained soils of the Cove and Minniece series. These are nearly level soils in basins and drainageways. The effective rooting depth is 15 inches.

Fertility is moderately low or low. The available water capacity is low, and permeability is very slow. Surface runoff is slow to ponded, and there is no erosion hazard.

These soils are generally better suited to permanent pasture than to other uses because drainage is not feasible. Even where the soils are drained and fertilized and improved varieties of grasses and legumes are used, productivity is low to very low. The benefit derived from improving these areas is questionable.

CAPABILITY UNIT Vs-1

Hillsboro bouldery silt loam, 3 to 8 percent slopes, is the only soil in this unit. This is a well-drained, undulating soil on terraces. It is more than 5 feet deep and is bouldery throughout.

The natural fertility is moderately high, and the organic-matter content is medium. The available water capacity and permeability are moderate. Surface runoff is slow, and there is only a slight erosion hazard.

This soil is better suited to woodland than to other uses. It is generally too bouldery for cultivation. Small areas that are free of boulders, or where boulders have been removed with special equipment, are u. ed for gar
den plots and suburban development. In areas that have been logged, some light grazing is possible.

CAPABILITY UNIT VIe-1

This unit consists of deep and moderately deep, well-drained soils of the Cinebar, Kinney, Larchmount, and Olympic series. These are gently sloping to moderately steep soils on terraces, mountain foot slopes, and
mountains.

Fertility is low to moderate. The available water capacity is moderate to very high. Permeability is moderate to moderately slow. Surface runoff is slow to rapid, and the hazard of erosion is slight to severe.

The soils in this unit are better suited to woodland than to other uses. In cleared areas, long-lived pasture of tall fescue, white clover, and subterranean clover can be grown. The pasture stands should be renewed only when they deteriorate or become weedy.

CAPABILITY UNIT VIe-2

Washougal gravelly loam, 8 to 30 percent slopes, is the only soil in this unit. This is a somewhat excessively drained soil that is moderately deep to sand and gravel. It occurs on terraces.

Fertility is low, and available water capacity is moderate. Permeability is moderately rapid in the uppermost part and rapid in the lower part. Surface runoff is medium to rapid, and the hazard of erosion is moderate to severe.

This soil is well suited to woodland. The moderately steep slopes limit the use of farm equipment, and a severe erosion hazard limits use of the soil for crops. In cleared areas, pasture of long-lived grasses and legumes, such as tall fescue and subterranean clover, can be grown. Stands should be renewed only when they become too weedy or have deteriorated.

CAPABILITY UNIT VIe-3

This unit consists of deep and moderately deep, moderately well drained to somewhat excessively drained soils of the Cinebar, Cispus, Gee, Hesson, Hillsboro, Kinney, Lauren, Olequa, Olympic, and Sara series. These are moderately steep to very steep soils on terraces, uplands, and mountains.

Fertility is low to moderately high. The available water capacity is moderate to very high. Permeability is very rapid to very slow. Surface runoff is medium to very rapid. The hazard of erosion is moderate to very severe.

The soils in this unit are well suited to woodland. They are too steep for cultivation.

CAPABILITY UNIT VIe-4

This unit consists of moderately deep and deep, welldrained and somewhat excessively drained soils of the Cinebar, Kinney, Larchmount, Olympic, and Washougal series. These are steep and very steep soils on terraces, uplands, and mountains.

Fertility is low to moderate. The available water capacity is moderate to very high. Permeability is generally moderately rapid to moderately slow, but it is rapid in the lower part of the Washougal soils. Runoff is rapid to very rapid, and the hazard of erosion is severe to very severe.

The soils in this unit are well suited to woodland. They are too steep for cultivation.

CAPABILITY UNIT VIe-5

This unit consists of deep, somewhat excessively drained soils of the Lauren and Wind River series. These are moderately steep to very steep soils on terraces.

Fertility and the available water capacity are moderate. Permeability is generally moderately rapid, but it is rapid in the substratum. Surface runoff is moderate to very rapid, and the hazard of erosion is moderate to very severe.

The soils in this unit are well suited to woodland. They are too steep for cultivation.

CAPABILITY UNIT VIw-1

Minniece silty clay loam, 3 to 20 percent slopes, is the only soil in this unit. This is a poorly drained soil in

drainageways. The effective rooting depth is about 15 inches.

Fertility and the available water capacity are low. Permeability is very slow. Surface runoff is slow to medium, and the hazard of erosion is slight to moderate.

Drainage is generally not feasible, and the soil is better suited to permanent pasture than to other uses. Even where the soil is drained and fertilized, and improved varieties of grasses and legumes are used, productivity is low to very low. The benefit derived from making improvements is questionable.

CAPABILITY UNIT VIs-1

This unit consists of moderately deep and deep, welldrained soils of the Hesson, Olympic, and Yacolt series. These are nearly level to moderately steep soils on terraces and mountains. They are very stony and stony.

Fertility is moderately low to moderate. The available water capacity is moderate to high. Permeability is moderate to moderately slow. Surface runoff is slow to rapid, and the hazard of erosion is slight to severe.

The soils in this unit are well suited to woodland. They are generally too stony for cultivation. If logged, they can be used for light grazing, but this is not a general practice.

CAPABILITY UNIT VIs-2

Pilchuck fine sand, 0 to 8 percent slopes, is the only soil in this unit. This is a deep, nearly level and gently sloping, somewhat excessively drained soil on bottom lands.

Fertility and the available water capacity are low. Permeability is rapid. Surface runoff is very slow, and there is no erosion hazard.

If unirrigated, this droughty soil is better suited to woodland or native grasses than to other uses.

CAPABILITY UNIT VIIIe-1

This unit consists of Rough broken land. This land type is very steep and is broken by intermittent drainage channels. It is suited to woodland and wildlife habitat.

CAPABILITY UNIT VIIIw-1

This unit consists of Riverwash (cobbly) and Riverwash (sandy). These land types are not suited to cultivation, because of the frequent flooding, the tidal wash, and the nature of the soil material. Some areas support stands of willows, cottonwood, grasses, and weedy plants. These land types are better suited to wildlife habitat and recreation than to other uses.

CAPABILITY UNIT VIIIs-1

This unit consists of Fill land. This land type is made up of areas that have been filled artificially with earth, with sand pumped from the river, or with trash and then smoothed over. Areas of this land type are used for urban development
.

CAPABILITY UNIT VIIIs-2

This unit consists of Rock land, which has a high proportion of rock outcrop. The soil material is very shallow and very steep, and the areas are deeply dissected. Trees are sparse and scrubby, and the cover is brush. These areas are suited to forestry, but are better suited to wildlife habitat and recreation.

Estimated Yields

Estimated average yields per acre of the principal crops grown in Clark County are given for two levels of

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management in table 2. In columns A are listssd yields to be expected under common management. In columns B are those to be expected under improved management. The following are examples of specific management practices, by crops, under which a farmer can obtain the yields shown in columns B in table 2.

Hay:

Alfalfa-grass

1. Use of recommended varieties.
2. Inoculation of legume seed.
3. Preparation of a clean, firm seedbed.
4. Fertilization in amounts determined by ;oil tests, or about 32 pounds of nitrogen and 80 pounds of berated phosphorus per acre for seeding year, and 60 to 80 pounds of phosphorus per acre in alternate years. 5. Maintenance of a pH value above 6.0.

Pasture:

White clover-orchardgrass

1. Use of recommended varieties.
2. Inoculation of legume seed.
3. Preparation of a clean, firm seedbed.
4. Fertilization in amounts determined by soil tests, or 32 pounds of nitrogen and 80 pounds of phosphorus at seeding per acre, 32 pounds of nitrogen and 40 to 60 pounds of phosphorus per acre early in spring, and 60 pounds of nitrogen per acre in midsummer.
5. Maintenance of pH value above 6.0.
6. Use of recommended pasture management and proper irrigation practices.

Cash crops:

Pole beans

1. Use of recommended varieties.
2. Use of a seeding rate to produce plants spaced 2 to 3 inches apart in rows, generally 22 to 30 pounds of seed per acre.
3. Fertilization in amounts determined by soil tests, or about 100 pounds of nitrogen, 160 pounds of phosphorus, and 80 pounds of potassium at planting; s:idedress crop at the rate of 45 pounds of nitrogen and 200 pounds of phosphorus per acre.
4. Use of proper irrigation practices, generally 6 to 8 sprinkler applications per season.
5. Under continuous cropping, use of a winter cover crop of rye seeded at the rate of 100 pounds per acre. Under a conservation cropping system, grow pole beans for 2 to 3 years, legumes and grasses for 3 to 6 years.

Strawberries-

1. Use of recommended varieties.
2. Maintenance of a plant population of 5,000 to 8,000 plants per acre in 18-inch rows.
3. Fertilization in amounts determined by soil tests, or about 90 pounds of nitrogen, 140 pounds of phosphorus, and 80 pounds of potassium per acre.
4. Use of irrigation if available.
5. Inclusion of grasses and legumes as part of a conservation croping system.

The figures in columns A are based largely on observations and data collected during fieldwork for this soil survey and on information obtained in interviews with farmers and other agricultural workers experienced with the soils and crops of this area. Comparisons were made with yield tables for other counties in Washington that have similar soils.

The yields in columns B are based largely on data and estimates made by men who have had experience with the crops and soils of this county. The known deficiencies of the soils were considered in judging how much yields might increase if these deficiencies were corrected within practical limits. These limits cannot be precisely defined, nor can response to good management be precisely predicted. By comparing yields in columns B with those in columns A, however, one can gain some idea of, how a soil will respond to good management. On practically all soils of the county, more intensive management will bring increased yields.

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Use of the Soils for Woodland

About 58 percent of Clark County is in woodland. About 93 percent of the woodland is privately owned, 6 percent is State owned, and about 1 percent is owned by the Federal Government.

Most of the forested areas have been logged one or more times. Intensive woodland management is beginning to be practiced on large timber holdings and is gaining limited acceptance on small private woodlands. The State Department of Natural Resources has undertaken an extensive forest rehabilitation program in the Yacolt Burn area of eastern Clark County. This program has been highly successful in controlling fires and in reforestation of the area.

Soil factors affecting woodland production

Such soil properties as texture, structure, organicmatter content, soil reaction, aspect, and position each affect tree growth to a degree. The combination of all soil factors has a marked effect on tree growth and management. Attempts to measure the relative elects of individual soil properties have met with only limited success. The woodland interpretations given in tables 3 and 4 are based on the combined effects of all soil factors pertinent to the growth of trees.

Table 3 in this section shows the woodland suitability groups of soils in this county and gives facts on potential productivity and management hazards. Table 4 gives yield data for Douglas-fir.

Following is a brief explanation of the terms used in these tables.

Potential soil productivity refers to the potential capacity of a soil to produce trees. It is based on a standard for comparison, or the site index. For Douglas-fir, the site index is based on the height that the dominant and codominant trees will reach at 100 years of age. To establish the average site index for Douglas-fir on a particular soil, the height of the trees in relation to their age is measured. The site index is then determined from tables (9) that have been established as a result of research. Other site tables are available in other publications.

Seedling mortality ratings are based on soil-related causes of mortality for naturally occurring or planted seedlings. The rating is slight if expected mortality is less than 25 percent. It is moderate if between 25 and 50 percent of the seedlings die, and it is severe if mortality is more than 50 percent.

Plant competition is slight if natural regeneration of desirable trees is adequate and invading plants do not interfere with adequate development of planted seedlings. It is moderate if invading plants delay but do not prevent development of normal, fully stocked stands. Competition is severe if trees cannot regenerate naturally without intensive site preparation and weeding.

Equipment limitation is slight if there are no restrictions on the kind of equipment or on the time of the year that the equipment can be used. It is moderate if use of equipment is restricted by one or more factors, such as slope, stones or other obstructions, seasonal wetness, physical soil characteristics, injury to tree roots, soil structure, or soil stability. Equipment limitations are severe if special equipment is needed and its use is severely restricted by one or more soil factors, or if use of equipment is hazardous.

Erosion is the detachment and movement of soil particles, primarily by water. Terms for erosion hazard indicate the relative amount of erosion that would take place if the surface soil were left bare.

The windthrow hazard is slight if roots hold the trees firmly against a normal wind. It is moderate if some trees are expected to blow down during periods of excessive soil wetness and high winds. The hazard is severe if many trees are expected to blow down during periods of soil wetness and moderate to high winds.

Woodland suitability groups

The soils of Clark County have been placed in woodland suitability groups on the basis of their suitability for trees. Each group consists of soils that are suitable for about the same kinds of trees, that require about the same use and management, and that have about the same potential productivity.

Table 3 describes these groups, their potential productivity, and the management hazards or limitations to be expected.

Woodland suitability group symbol

The woodland suitability group symbol in table 3 consists of four elements, for example, 2oH3 and 2dL3. The first element of this symbol refers to the relative productivity of the soils of Clark County for Douglas-fir. On this basis, the soils have been placed in three of the five classes in the system: class 2, made up of soils of high productivity (site index 155 to 184); class 3, made up of soils of medium productivity (site index 125 to 154); and class 4, made up of soils of low productivity (site index 95 to 124). None of the soils are in class 1, which consists of soils of very high productivity (site index more than 184), nor in class 5, which consists of soils of very low productivity (site index less than 94).

The second element of the symbol refers to soil characteristics that cause important hazards or limitations in woodland use or management. The soils are in five subclasses, identified as follows : subclass d, limitations of restrictive rooting depth; subclass f, limitations of gravel; subclass o, no limitations; subclass r, limitations of relief or slope; subclass s, limitations of excessive sandiness; and subclass x, limitations of stoniness and rockiness.

The third element of the symbol indicates the position in the site class of the average site class: H represents high; M, middle; and L, low.

The fourth element of the woodland suitability group symbol indicates the principal limitations of the soils for certain kinds of trees. In table 3 the limitations are seedling mortality (expressed as 2), plant competition (3), equipment limitation (4), erosion hazard (5), and windthrow hazard (6).

'This section was prepared by David L. Hintz and Norris Quam, woodland conservationists, Soil Conservation Service.

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Use of the Soils for Wildlife

Fish, waterfowl, upland birds, deer, and other kinds of wildlife provide recreation and a source of income in Clark County. To maintain this valuable fish and wildlife resource, a well-planned conservation program is necessary.

This section mentions the principal kinds of wildlife in the county and describes kinds of habitat needed. In table 5 the soils are grouped according to their capacity to provide suitable habitat.

Kinds of wildlife

In this county the many tributaries of the Columbia River are important waters for steelhead trout, Chinook and silver salmon, and for other fish that come into the fresh waters of the Columbia River from the Pacific Ocean to spawn. The streams provide good fishing for these fish and for rainbow and cutthroat trout.

Flocks of geese and ducks feed and rest in the wet lowlands along the Columbia River during their fall and spring migrations. Blue-winged teal and mallard commonly nest in the fields in this area. The colorful wood duck nests in depressions in the groves of cottonwood trees that border the many sloughs of the Columbia River.

The farmland of the county provides pheasant hunting in fall. Band-tailed pigeon, blue grouse, and ruffed grouse are also taken by hunters.

The population of black-tailed deer is steadily increasing as their habitat improves through timber harvest or accidental fires. Black-tailed deer are also common in farmland thickets.

[3] By PAUL M. SCHEFFER, western states biologist, Soil Conservation Service.

Wildlife habitat

The kinds and numbers of wildlife that live in a particular area depend on the kind of habitat available. In Clark County, there are four general types of wildlife, and these have varying habitat needs. They are described in the following list.

Finds of wildlife	*Elements of habitat needed*
1. Farmland wildlife: Chinese pheasant, California quail, mourning dove, band-tailed pigeon, and western meadowlark.	Grain crops, grasses, legumes, and brushy cover.
2. Wetland wildlife: ducks, geese, western and Brewer's blackbirds, Wilson's snipe, and killdeer.	Grain crops, grasses, legumes, and wetlands or shallow-water impoundments.
3. Brushland wildlife: cottontail rabbit, western grey squirrel, numerous kinds of songbirds, and ruffed grouse.	Brushy cover, grasses, legumes, and hardwood thickets.
4. Forest wildlife: black-tailed deer, mountain beaver, Townsend's chipmunk, black bear, blue grouse, red squirrel, Steller's jay, and Washington hare.	Coniferous forest-logged, burned, or open stands that have an understory of brush, grass, and forbs.

The suitability of a site for a water habitat for pondfish depends on the capability of the soils to hold impounded water. If water can be safely impounded on a soil to a depth of 8 to 10 feet, such pondfish as rainbow trout, bass, bluegill, catfish, and perch can be produced. Freshwater streams are not discussed in this section.

Wildlife sites

The soils in each wildlife site, as shown in table 5, can produce the same kind of habitat. Each site has been rated excellent, good, poor, or unsuitable according to its capacity to produce the plants that provide wildlife food and protective cover. The suitability of the soils for water impoundment for wetland wildlife or pondfish is also rated.

A wildlife site that is rated excellent for production of the kind of habitat needed by a given kind of wildlife will need only minimum management. A rating of good indicates that average management of the site will be required. A rating of poor indicates that much management of the site will be needed or that management is of doubtful value for the kind of wildlife specified. A rating of unsuitable indicates that the use of the site for production of the specified kind of wildlife is not feasible.

As shown in table 5, a site that has a low rating for a given kind of plant cover has a corresponding Low rating for the kind of wildlife that needs this kind. of plant cover. An exception to this is the coniferous forest. On soils poorly suited to Douglas-fir, the timber stands are open, and this permits growth of an understory of grasses, forbs, and brush, which attracts forest wildlife. Even in dense forest stands, however, favorable habitat also results from conservation management of timber, and harvesting methods, or accidental fire.

In interpreting the table, some adjustments need to be made for the steeper soils or those that have other limitations, such as stones or shallowness. The ratings in the table are based on soils that have a slope of 0 to 3 percent. More strongly sloping soils of the same series, or soils that have other limitations, would not have so high a rating for upland wildlife or for grain crops. They would need, for example, more intensive management to produce the grain crops that attract pheasants.

Table 5 shows, for example, that the Sauvie soils in the Columbia River Flyway site are excellent for farmland wildlife, which includes Chinese pheasant. The Sauvie soils, however, are currently used mainly for pasture, and a well-tended pasture harbors few, if any, pheasants. To encourage pheasants, the operator needs to plant protected strips of grain throughout his pasture each year and to establish shrub hedgerows along fence lines, roadsides, and streambanks.

The foregoing illustrates the advantages and limitations in the use of table 5. This table is helpful in locating suitable habitats but does not provide detailed guidance on management. Those who wish help in planning longterm management of soil or water for wildlife can consult local representatives of the Soil Conservation Service and the State Game Department.

Engineering Uses of the Soils

Certain soil properties and qualities are of special interest to engineers because they affect the design, installation, and maintenance of many structural works. Among the properties and qualities most important to the engineer are permeability, structure, strength, texture, plasticity, workability, and reaction. In many places the depth to free water, restrictive or compacted layers, and topography of the site are of equal importance.

This section contains information that engineers can use to

1. Make soil and land use studies that will aid in the selection and development of industrial, business, residential, and recreation sites.
2. Make preliminary estimates that will aid in planning agricultural drainage systems, irrigation systems, irrigation reservoirs, dikes, and other structures for conservation of soil and water.
3. Make estimates of runoff and sediment characteristics for use in planning dams, channels, and other water control structures.
4. Make preliminary evaluations of the soils and foundation sites that will aid in selecting locations for highways and airports and in planning detailed investigations for these locations.
5. Locate probable sources of sand, gravel, rock for crushing, and other construction material.
6. Correlate performance of engineering structures with soil mapping units to develop information that will be useful in designing and maintaining such structures.
7. Determine the suitability of soils for crosscountry movement of vehicles and construction equipment.
8. Supplement information obtained from published maps, reports, and aerial photographs for the

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purpose of making maps and reports that can be used readily by engineers.

9. Develop other preliminary estimates for construction purposes pertinent to a particular area. With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or excavations deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected. The estimates given generally apply to a depth of about 5 feet, and, therefore, interpretations normally do not apply to a greater depth.

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Much of the information in this section is presented in tables. Only the data in table 6 are from actual laboratory tests. The estimates in table 7 and the interpretations in table 8 are based on the test data, on estimates made by specialists who are familiar with the soils of the county, and on field performance.

At many construction sites, major variations in soil characteristics occur within the depth of the proposed excavation, and several kinds of soil occur within short distances. Specific laboratory data on engineering properties of the soil at the site should be obtained before planning detailed engineering work.

Some of the terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms as they are used in soil science.

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Engineering classification systems

Two systems for the classification of soils are in general use among engineers : the Unified soi1 classification system (18), and the system approved by the American Association of State Highway Officials (1). The estimated classification of the soils of Clark County by the two systems are included in table 6 of this survey.

In the Unified system, soil material .is placed in fifteen classes based on those characteristics that indicate how the soil behaves as engineering construction material. Through identification of the texture, plasticity, and behavioral characteristics, soils can be placed in the proper class or combination of classes. The letter symbols GW, GP, GM, GC, SW, SP, SM, and SC identify the coarse-grained, gravelly and sandy classes; ML, CL, OL, MH, CH, and OH identify the fine-grained classes; and Pt identifies highly organic material.

Soils for subgrade materials are classified according to the system approved by the American Association of State Highway Officials. This system consists of seven principal groups. They range from high suitability, or classification A-1, which consists of gravelly soils of high bearing capacity, to classification A-7, which consists of clay soils that have low strength and undesirable construction properties.

The U.S. Department of Agriculture system of classifying soils according to texture is primarily for agricultural use, but the textural classification is useful in engineering also. In this system, soils are classified according to the proportional amounts of different sizes of mineral particles. A soil that is 40 percent clay particles, for example, is called clay. Beginning with the largest, the particle sizes are designated as cobblestones, gravel, sand, silt, and clay.

Test data

Table 6 contains a summary of test data for some of the important Clark County soils, which were sampled and tested under direction of the Washington State Institute of Technology. This table shows the classification according to the AASHO and Unified systems for significant depths of each sample and data for liquid limit, plasticity index, maximum density, and optimum moisture.

Estimated properties

Table 7 lists certain properties that form an important base for making engineering interpretations. The soil series are listed in alphabetic order, and the mapping symbols are given.

The columns that give texture of significant horizons identify the depths to which the estimated properties apply.

An expansion of the soil test data has been made to cover all the applicable mapping units. Supplementary data from the Soil Conservation Service Riverside Testing Laboratory and estimates by local specialists complete this table.

Permeability and available water capacity are expressed as a range. They are especially important in drainage and in problems relating to soil moisture. These ranges are based upon an interpretation of the texture and structure for the particular depth.

Most of the soils in the county are sufficiently deep over bedrock that the bedrock generally does not affect their use. Kinney, Larchmount, Minniece, and Olympic soils have bedrock at a depth of about 4 or 5 feet. Olympic soils, shallow variant, and Vader soils have bedrock at a depth of about 30 inches.

A seasonal high water table within a depth of 48 inches occurs in the following soil series : Cove ; Cove, thin solum variant; Dollar; Gee; Gumboot; Hockinson; Lauren, cemented substratum; McBee; McBee, coarse variant ; Minniece ; Minniece, thin solum variant ; Odne ; Olequa, heavy variant; Powell; Sara; Sauvie; Semiahmoo; Semiahmoo, shallow variant; and Tisch.

Engineering interpretations

In table 8 suitability of the soils for topsoil and road fill are given, as well as features that affect use of the soils for highways, dikes or levees, farm ponds, irrigation systems, terraces and diversions, and waterways. Also given are soil features that affect agricultural drainage.

The Pilchuck, Puyallup, and Wind River soils are a good source of sand. Two to three feet of overburden must be removed from the Lauren, Puyallup, and Wind River soils, and screening is needed for the Puyallup and Wind River soils.

The Lauren, Sifton, and Washougal soils are good sources of gravel, but screening and washing are required in most places.

The interpretations in this table are based on information in table 7, on test data obtained by the Division of Industrial Research, Washington State University, and on field performance. They are general and will not take the place of examination and evaluation of the soil at the site of a planned engineering project.

The soil features noted in table S may affect the selection of a site, the design of a structure, or the application of a practice for land treatment. Some features may be helpful in one kind of engineering work, but a hindrance in another. For example, a rapidly permeable substratum would make a soil unsuitable as a site for a farm pond.

Soil that consists of a mixture of clay, silt, and coarser materials is not so susceptible to frost heaving and subsequent frost boils as soil that contains a high percentage of silt or very fine sand. A soil is susceptible to damaging frost action if about 10 percent or more of the soil particles pass a No. 200 sieve.

Uniform soil materials are needed in subgrades to prevent frost damage because lack of uniformity in expansion of material causes damage from frost heaving. Some deposits of glacial till contain lenses or pockets of fine sand and silt that cause differential frost heaving. In areas where subgrade is laid over glacial till, the subgrade material should be thick enough to withstand frost heaving.

Muck is not a suitable material for use in foundations of roads or in other engineering structures. Pockets of muck and other highly organic material should be removed from roadways or foundations and replaced with a more suitable material to a depth of 4 feet above the

high water table. If possible, however, roads should be located away from areas of deep muck. A thorough field investigation is necessary before planning engineering structures in muck or highly organic soil.

Drainage ditches, constructed before earthwork is started, make some soils that have a high water table more suitable for borrow and for roadway excavation. Underdrains may be needed where a perched or normal high water table makes the soil unstable.

On bottom lands that may be flooded each year, roads should be built on a continuous embankment, so that the pavement surface is at least 3 feet above the highest level reached by the water table.

Nonfarm Uses of the Soils

This section has been developed for suburban landowners, planners, and developers. Table 9 gives the degree and kind of limitations of the soils of Clark County for specified uses. It supplements the soil maps at the back of the survey, which show considerable detail but cannot be precise for each small area of the county. For example, not all the small wet areas nor all the seasonal seep areas on hillsides are shown on the map.

The suitability of the soils for nonfarm uses is rated according to such soil characteristics as permeability, available water capacity, topography, depth, and stability. These ratings do not take into account the inaccessibility of some soils, the distance from population centers, or the development of such utilities as roads, powerlines, and facilities to provide water for domestic use. The interpretations are based on observation and on estimates of the conditions that would be expected to restrict various uses.

The ratings for shrink-swell potential and corrosivity are based on the most limiting soil layer.

For septic tank filter fields and sewage lagoons, only the undisturbed soil is considered, and layers that have been mixed or reworked for fill material are not considered. The limitation ratings for these purposes depend on permeability. In some soils there are thin, slowly permeable layers that considerably alter the permeability for septic tank filter fields. If these layers are known, the limitation rating shows or reflects their presence.

The limitation ratings for residential foundations are for undisturbed soil and not for layers that have been mixed or reworked for fill material.

The limitation ratings for golf fairways are based on the ability of the soils to support vegetation and to withstand foot and golf-cart traffic.

The limitation ratings for picnic areas and campsites are based on the ability of the soils to withstand heavy foot and vehicular traffic and on ease of movement for these purposes.

Fertilizer is needed in nearly all areas, and irrigation in many, for satisfactory plant growth. Fertilizer should be applied according to results of soil tests made after the site has been prepared.

By A. R. HIDLEBAUGH, assistant State soil scientist, Soil Conservation Service.

Formation and Classification of the Soils

This section discusses the major factors of soil formation as they relate to the soils of Clark County and briefly explains the system of classifying soils into categories broader than the series. It also contains data obtained by physical and chemical analyses of seven selected soils.

Factors of Soil Formation

Soils are natural bodies that occupy space on the earth's surface. Their characteristics are determined by the nature of the parent material and changes that have taken place in it by soil-forming processes. These processes are controlled by climate, living organisms (chiefly vegetation), parent material, relief, and time.

The five factors of soil formation are interdependent. Each tends to modify the effects of the other four. For example, the kind of vegetation is in part determined by the material in which it grows, by the topography, and by the climate. Differences in relief influence, through runoff and drainage, the effects of climate.

Climate

Clark County has a mild marine climate that is typical of the northwestern part of Oregon and the western part of Washington. It has mild, wet winters and moderately warm, dry summers. The climate reflects the influence of the Cascade Mountains to the east and the parallel Coast Range to the west. Nearly 75 percent of the annual precipitation normally occurs from October 1 to March 31. The remaining 6 months, from April 1 to September 30, receive only 25 percent of the total precipitation.

The average annual precipitation differs greatly from place to place. This difference is directly related to the effects of the two bordering mountain ranges. The average annual precipitation on much of the Coast Range and the Cascade Mountains exceeds 100 inches. Precipitation at lower altitudes and toward the center of the basin between the two mountain ranges is much less. The annual precipitation at Vancouver is about 37 inches; the precipitation reaches 114 inches in the Cascade Mountains in the northeastern corner of the county. During the growing season, however, the range in precipitation is small. For example, precipitation for July and August combined averages 1.40 inches at Vancouver, the driest station, in comparison with 2.77 inches at Cougar, the wettest station. The average annual snowfall at Vancouver is 8.4 inches, and it is estimated to exceed 200 inches at an elevation of 3,000 feet in the eastern and northeastern parts of the county.

The difference between the average temperatures of the coldest and the warmest months is 28.5° F. The average January temperature at Vancouver is 38.4°; the average July temperature is 66.8°. The soil is seldom frozen, and the processes of soil formation are active throughout the year.

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

Climate is an active factor of soil formation. It influences the formation of soils through its influence on kinds and amounts of vegetation, the rate of weathering and leaching, translocation of clay, reduction and transfer of iron, and erosion. For about 6 months of the year rainfall is sufficient to permit nearly continuous leaching.

During dry summers, the soils on terrace,; in the southwestern part of the county approach the wilting point of plants, to a depth of about 30 inches. These climatic conditions and the nature of the parent material are necessary for the development of Alfisols, represented in this county by Gee and Sara soils.

In the eastern part of the county, where rainfall is high, there is sufficient moisture to maintain the soil moisture content above the wilting point, except for the uppermost few inches. The soils in this area have high porosity, low bulk density, and low base saturation, and they exhibit smeariness when wet. Cindbar, Kinney, and Yacolt soils are examples of the soils of this climatic zone.

Soils of the Hesson and Olympic series developed in areas between these extremes of climate. These soils dry sufficiently in summer to permit precipitation, orientation, and accumulation of downward-moving fine clay. This movement results in development of a textural B horizon.

Living organisms

Plants, micro-organisms, earthworms, and other forms of life that live on or in the soil are active in soil-forming processes. They help to decompose plant residue, contribute organic matter when they die, and also affect the chemistry of the soil and accelerate soil development. Certain living organisms also help to convert plant nutri
ents to forms that are more readily used by higher plants.

The five major kinds of natural vegetation in Clark County are coniferous forest, hardwood-shrub, marsh, fern-prairie, and hardwood-grass types.

The typical coniferous forest is in the well-drained areas. Douglas-fir is the dominant species; grand fir, western redcedar, hemlock, big-leaf maple, vine maple, dogwood, and alder are normally present. Salal, salmonberry, Oregon-grape, and swordfern are characteristic species in the understory. This vegetative type is on nearly all of the well-drained soils, regardless of precipitation. There is little variation in composition. Olequa, Hillsboro, Olympic, and Vader soils developed under this kind of plant cover. This vegetative type reflects the deep, well-drained, permeable characteristics of these soils.

Hardwood-shrub vegetation is in the drainageways and depressions on terraces and uplands. The typical composition is alder, Oregon ash, Oregon white oak, rushes, sedges, hardhack, vine maple, and skunkcabbage. Odne, Cove, and Gumboot soils support this kind of vegetation. These soils have a thick, nearly black surface layer that reflects the accumulation of organic matter under deciduous vegetation, and the poor drainage of the soils.

In the marsh areas the vegetation is mainly rushes, sedges, hardhack, skunkcabbage, and some alder and ash. The remains of these plants are the parent material of Semiahmoo and Tisch soils.

Fern-prairie vegetation grows on well-drained to excessively drained soils. The vegetation consists of grasses, strawberry, cinquefoil, bracken fern, swordfern, other herbaceous plants, and a scattering of Douglas-fir. The presence of this kind of vegetation in an area that is dominantly coniferous forest has not been explained. The surface layer of the soils under this kind of vegetation is thick and black and has high organic-matter content. Soils of the Bear Prairie, Mossyrock, and Sifton series reflect this vegetative influence.

Hardwood-grassland is peculiar to the recent alluvial soils. The vegetative composition is cottonwood, willow, and native grasses. Sedges predominate in the low, wet areas. Sauvie, Puyallup, Newberg, and Cloquato soils support this kind of vegetation. Pilchuck soils, which are

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somewhat excessively drained, support heavy stands of Scotch-broom.

Except for the mixing of soil materials in the upper horizons of well-drained soils by small burrowing animals, the effect of animal activity on soil formation in Clark County is of little significance. The damming of small streams by beaver, however, has been significant in the formation of soils adjacent to streams. Man has drastically altered much of the plant cover in the county and has influenced the direction and rate of soil :formation by clearing or clear-cutting the forests, by cultivating and draining the soils, by introducing new plants, and by applying fertilizer and lime.

Parent material

Soil material is the product of physical and chemical weathering of rocks and minerals. Parent material can consist of fragments of widely varying sizes or can be of uniform texture. Over a long period of time, the general effect of soil-forming processes is to mask the differentiating influence of parent material. However, the parent material is not completely altered during the process of soil formation; most soils retain some original characteristics.

The soils of Clark County formed through modification of the following kinds of parent material : (1) alluvium on flood plains, stream bottoms, and terraces, (2) residuum on hills and mountains, (3) volcanic ash and pumice, (4) lacustrine deposits in depressions, axed (5) organic material. Differences in size, hardness, and distribution of particles, and in permeability, thickness, and mineralogy of the parent material have influenced the nature of the soils. The Cloquato, Puyallup, Sauvie, and Newberg soils are examples of soils that inherited their texture directly from parent alluvium. The nature of the parent material to a great extent governs the kind and degree of alteration. The Olympic soils, for example, are redder than the Cinebar soils because the parent material of the Olympic soils has a higher potential than that of the Cinebar soils for the production of reddish iron oxides.

The Olympic, Kinney, and Vader soils developed partly in residuum and partly in colluvium that weathered from bedrock. These soils tend to be silty or clayey. They vary in thickness and in content of rock fragments. The Vader soils weathered from sedimentary rock. They are silty and contain fewer more strongly weathered rock fragments than the Olympic soils, which are more clayey and which developed in material weathered from igneous rock. Sandstone and basalt residuum have different potentials for alteration in soil formation because they contain different kinds and amounts of minerals.

Cispus and Cinebar soils developed in volcanic ash and pumice. The parent material is permeable and weathers readily. The source of this material is presumably eruptions of Mount St. Helens. The particles become finer and the thickness decreases with distance from the source. Cispus soils are near Mount St. Helens and are coarse textured. Cinebar soils are farther away and are finer textured.

The Cove soils developed in clayey, lacustrine sediments. These soils have clayey textures that are inherited directly from the parent material.

Organic materials are the parent material of Semiahmoo and Tisch soils. These materials accumulated where conditions were favorable for growth and decay of watertolerant plants. Organic parent materials are in various stages of decomposition. They are layered, and they contain variable quantities of diatomite, pumice, ash, and mineral soil materials.

Relief

In Clark County the topographic features can be classified as mountains, mountain foot slopes, terraces, basins, and bottom lands.

The Cascade Mountains, in the eastern and northeastern part of the county, are at elevations ranging from 1,500 to about 4,000 feet. They are rugged, very steep,

and dissected by many streams and drainageways. The soils are permeable. Runoff is rapid, and erosion is active in areas devoid of plant cover. The soils in this area are not droughty. Precipitation is sufficient to offset runoff losses. Soils of the Larchmount, Kinney, Cinebar, and Cispus series are mountain soils. The high precipitation in this area results from the cooling of the air and the condensation of moisture as the marine air rises over the mountains. The soils are continuously moist; this condition probably accounts for the absence of clay films.

Mountain foot slopes of the Cascades are, at an elevation ranging from 600 to 1,500 feet. They are not so rugged as the higher areas; slopes are steel), but shorter, than those in the mountains. Olympic and Cinebar soils, which are permeable, dominate this area. Relief is milder, and precipitation and runoff are less than in the mountains. The soils in this area are dry for short periods in summer. Orientation of silicate clays is evident in the B horizon.

The alluvial terraces support most of the farming in the survey area. They are in the central part and western half of the county. Elevations range from 35 feet to more than 800 feet. Several small streams flow westerly and are entrenched deeply in the terrace.;. The boundaries between the major soils on terraces are marked by these streams. The terraces are nearly level to gently rolling. Moderately steep to very steep slopes are limited to terrace fronts along the streams. Soils of the Dollar, Gee, Hesson, Hillsboro, Lauren, and Wind River series are terrace soils. Relief is reflected only to a minor degree in their formation. For example, the Gee soils near the base of slopes that grade to the depressional, poorly drained Odne soils are grayer and mottled nearer the surface in these areas than they are in other places. The lower part of the B horizon in Hillsboro soils is mottled where the soils occur in microdepressions.

The largest area of bottom land is on Lie flood plain of the Columbia River. During flood stage, the river deposits material on its flood plain. This deposition is mixed with the depositions from the Lewis, Washougal, and Lake Rivers, which results in intricate soil patterns. Relief is nearly level to gently undulating. Elevations range from near sea level to 35 feet above sea level. Soils of the bottom lands are of the Cloquato, Newt erg, Pilchuck, Puyallup, and Sauvie series. Minor differences in relief are reflected in the mottled profile of the Sauvie soils, which are often saturated, in contrast to the slightly elevated Cloquato soils, which are free of mottles.

Time

Some soils have very strongly developed horizons. Other soils nearby may be weakly developed. The time required for the formation of a given soil depends largely on the environmental factors. Parent materials in time develop into soils that reflect their position, the influence of living organisms, and the effect of climate. The Hesson soils, which formed on very old terraces, have strongly developed, distinct horizons. The McBee soils, which are associated with Hesson soils in drainageways, are young and have indistinct horizons.

A long period of time is needed to develop distinct horizons in rapidly permeable, somewhat droughty parent material. For example, the gravelly Lauren soils are about the same age as the loamy Dollar soils, but do not exhibit the distinct horizons that are characteristic of the Dollar soils.

The Olympic soils, which developed in residuum from basalt, have strong, distinct horizons. At higher elevations and in areas of higher rainfall, the Kinney soils of similar age show less pronounced development. The increased moisture in the soil and lower soil temperature slow the soil-forming processes. Gee and Sara soils developed in similar material, but of a different age: Sara soils have a stronger structural grade, finer textures in the A&B and B&A horizons, and lower base status throughout. These features indicate that Sara soils are older than Gee soils.

In the soils of the younger terraces, which are the well-drained Hillsboro and Wind River soils, the length of time that soil-forming factors have been active is apparent in the moderate accumulation of organic matter, the removal of carbonates, and the translocation of only small amounts of silicate clay and iron. Soils that formed in recent alluvium, such as those of the Cloquato, Newberg, Pilchuck, and Sauvie series, show only slight horizonation because of the short time the soil-forming processes have been acting on the parent material.

Classification of the Soils

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (3) and later revised (14). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and in September 1968 (17). This system is under continual study, and readers interested in the development of the system should refer to the latest literature available.

Table 10 shows the classification of each of the soil series represented in Clark County according to the present system.

The current system defines classes in terms of observable or measurable properties of soils (12). The properties considered are primarily those that permit the grouping of soils that are similar in genesis. The classification is designed to encompass all soils. It has six categories. Beginning with the most inclusive, they are the order, the suborder, the great group, the subgroup, the family, and the series. The placement of some soil series, particularly in families, may change as more precise information becomes available. The categories are briefly defined in the following paragraphs.

ORDER.-Soils are grouped into orders according to properties that seem to have resulted from the same processes acting to about the same degree on the parent material. Ten soil orders are recognized in the current system : Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates. Six of the ten soil orders are recognized in Clark County : Alfisols, Entisols, Inceptisols, Mollisols, Ultisols, and Histosols.

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Alfisols have a surface layer that has been darkened to a depth of several inches by organic matter. The B horizon has measurably more clay particles than the A horizon, uniform color, and strong to moderate structure. Some Alfisols have a fragipan. Base saturation is usually 40 to 70 percent. Alfisols are represented in Clark County by soils of the Gee, Minniece, Odne, Olequa, Sara, and Salkum series.

Entisols are recent soils in which there has been no horizon development. Entisols are represented by soils of the Pilchuck series.

Inceptisols occur mostly on young, but not recent, land surfaces. They are represented by soils of the Bear Prairie, Cinebar, Cispus, Dollar, Gumboot, Hockinson, Kinney, Larchmount, Mossyrock, Powell, Sifton, Tisch, Vader, Washougal, and Yacolt series.

Mollisols have a thick, dark-colored surface layer. Most of these soils formed under grass. This order is represented by soils of the Cloquato, Cove, Hillsboro, Lauren, McBee, Newberg, Puyallup, Sauvie, and Wind River series.

Ultisols are soils that are highly developed but still contain weatherable materials. They are represented by soils of the Hesson and Olympic series.

Histosols are organic soils. This order is represented by soils of the Semiahmoo series and the shallow variant of the Semiahmoo series.

SUBORDER-Each order is divided into suborders, primarily on the basis of the characteristics that seem to produce classes with the greatest genetic similarity. This grouping narrows the broad climatic range of the orders. The properties used to distinguish the suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences caused by climate or vegetation.

GREAT GROUP.-Great groups are established on the basis of uniformity in kinds and sequence of major soil

horizons and features. The horizons considered are those in which clay, iron, or humus has accumulated or those that have pans that interfere with root development or water movement. The features considered are the self-mulching properties of clays, soil temperature, the major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like.

SUBGROUP.-Subgroups are subdivisions of great groups. They consist of the central (typic) segment or intergrades that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order.

FAMILY.-Families are established within a subgroup primarily on the basis of properties important to the growth of plants or the behavior of soils when used for engineering purposes. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.-The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Chemical and Physical Properties of the Soils

The chemical and physical properties of selected soils of the Hillsboro, Hesson, Hockinson, Lauren, Odne, Olympic, and Sara series are given in tables 11 and 12. The data in the two tables can be used to classify soils and to develop concepts of soil genesis. They can also be used to estimate available water capacity, fertility, tilth, and other factors related to soil management.

All of the soil samples analyzed were taken from carefully selected pits. The samples are Considered representative of the soil material that is made up of particles less than 1 inch in diameter. The soil material was rolled, crushed, and sieved by hand to remove rock fragments more than 2 millimeters in diameter. Unless otherwise noted, all material that was analyzed passed the 2-millimeter sieve and was ovendry. Cation-exchange capacity was determined by sodium saturation, displacement with ammonium acetate, and determination of sodium displaced (11). Exchangeable hydrogen or exchangeable acidity was determined by displacement from soil with triethanolamine and barium chloride at pH 8.2 (10). Extractable sodium and potassium were determined by flame spectrophotometer (5). Organic carbon was determined by wet combustion in a modification of the Walkley-Black method (10). Total nitrogen was determined by the Kjeldahl method (2). Extractable iron was determined by titration of the extract obtained when the soil was treated with sodium ditaiomite (4, 6). Soil reaction was measured with a glass electrode at a soil-water ratio of 1 to 1.

Particle-size analysis was made by the pipette method (7, 8). Bulk density was determined from core samples using a 4.7- by 3.5-centimeter tube and an Upland-type core sampler (15). Moisture retained at 15 atmospheres was determined by pressure membrane apparatus using fragmented samples (11).

General Nature of the County

In this section the climate of Clark County is discussed. This is followed by a brief description of the water supply.

Climate

Clark County, approximately 70 miles inland from the Pacific Ocean and west of the Cascade Mountains, has the predominantly temperate marine climate typical of the West Coast. It has a dry season and pleasant temperature in summer, a mild but rather rainy winter, and a narrow range in temperature. Some of the factors that influence the climate are terrain and distance and direction from the ocean. The coastal mountains protect this area from the more intense winter storms that move inland from the ocean, and the Cascade Range shields it from the higher summer and lower winter temperatures of eastern Washington. Cold air in winter and the occasionally hot air in summer flowing west through the Columbia River Gorge has a decided influence on the climate.

Late in spring and in summer large high-pressure centers over the north Pacific Ocean bring a prevailing flow of cool and comparatively dry air from a northwesterly direction. As the air moves inland, it becomes warmer and drier. As a result a dry season begins late in spring and reaches a peak in midsummer. In July and August, it is not unusual for 2 or 3 weeks to pass without measurable rainfall.

In fall and winter, low-pressure centers in the Gulf of Alaska intensify and high-pressure centers become smaller and move south. Circulation of air around these pressure centers in the north Pacific bring a prevailing flow of warm, moist air into this part of the State from a southwesterly direction. As a result, winter temperatures are mild and the rainy season begins in fall, reaches a peak in midwinter, and decreases in spring.

Table 13 gives probabilities of freezing temperatures in spring and fall, and tables 14 and 15 give temperature and precipitation data. The data in these tables are based on records kept at the weather stations at Vancouver and Battle Ground. Tables 16 and 17 give precipitation data based on records kept at Ariel Dam and Yacolt. The station at Yacolt is inactive.

In the warmest summer months, afternoon temperatures range from the middle seventies to the lower eighties, and nighttime temperatures are in the fifties. Maximum temperatures exceed 90° F. on 5 to 15 days each summer and reach 100° or slightly higher in one summer out of three. Temperatures in the foothills and higher elevations of the county are slightly lower than those recorded in the valleys. The hottest weather generally occurs when hot, dry, easterly winds reach the area. In this kind of weather, humidity is low and the risk of forest fires is high. Following 1 or 2 days of unusually warm weather, cooler air from the ocean moves inland and afternoon temperatures return to the seventies and eighties.

By EARL PHILLIPS, climatologist for Washington, National Weather Service, U.S. Department of Commerce.

In the coldest months, afternoon temperatures range from the upper thirties to the middle forties, and nighttime readings from 25° to 35°. In most winters, a minimum temperature of below freezing occurs on 40 to 75 nights and a maximum temperature of freezing or below occurs on a few days. The coldest weather generally occurs when a high-pressure area develops over the Pacific Northwest and cold air from east of the Cascades reaches this area. The sky is frequently clear under these conditions; minimum temperatures range from 5° to 15° and maximum temperatures remain below freezing.

In an average year, the relative humidity ranges from about 50 percent in midafternoon to 85 percent at sunrise in the warmest and driest months and from 75 percent in midafternoon to 85 percent or higher early in the morning in winter.

The average annual precipitation, in inches, is shown in figure 18, which is an isohyetal, or equal rainfall, map of Clark County. As shown in this figure, the annual precipitation ranges from approximately 40 inches in the vicinity of Vancouver to between 75 and 110 inches along the foothills and higher elevations in the eastern part. Available records indicate that the heaviest precipitation probably occurs in the northeastern part of the county. The annual precipitation near Cougar, in the Lewis River valley, ranges from 72 to 172 inches. Rain

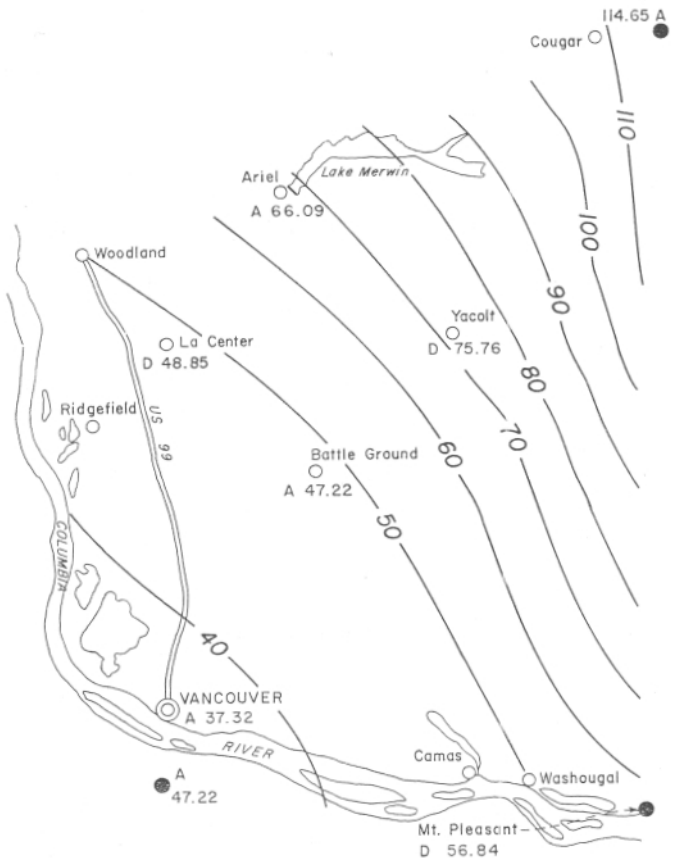

Figure 18.-The average annual precipitation at various weather stations in Clark County. The stations at Yacolt, La Center, and Mt. Pleasant are inactive.

fall of more than half an inch per hour can be expected once in 2 years. During the rainy season, precipitation is usually moderate in intensity and continuous over a period of time, rather than a downpour for a brief period. Rainfall of heavy intensity, however, occurs occasionally as the more intense weather systems move across the area. Precipitation amounting to 2 to 4 inches in a 24-hour period is recorded in the areas of heavier rainfall almost every year.

Thunderstorms occur on 1 or 2 days each month from March through October and have been recorded in all months of the year. In midsummer, thunderstorms are often accompanied by very light precipitation and by forest fires that have been started by the lightning.

Snow sometimes falls as warmer, moist air moves in following an outbreak of cold air. Snowfall is light at the lower elevations of the county. It seldom remains on the ground longer than a few days or accumulates to a depth of more than 6 inches. The amount of snowfall and the accumulation on the ground can be expected to increase rapidly at elevations above 1,500 feet. A "silver thaw," or glaze of ice, formed by rain falling through cold air moving westward through the Columbia River Gorge, occurs a few times each winter. These ice storms sometimes extend across most of the southern part of the county. The weight of the ice often causes limbs to break off the trees.

The number of clear or only partly cloudy days ranges from 5 to 7 days each month in winter, and from 10 to 15 days each month in spring and fall, and the number is more than 20 days each month in midsummer. The amount of sunshine received is about 20 percent of the daylight hours in winter, 45 percent in spring, and nearly 70 percent in summer. The number of hours of possible sunshine each day at this latitude ranges from 8 in December to 16 in June.

The potential evapotranspiration has been computed from temperature and precipitation data recorded at Vancouver from 1931 to 1960. Techniques developed by Palmer-Havens for applying the Thornthwaite method *(13)* were used in making the estimates. The potential evapotranspiration for the growing season is 24.5 and 26.1 inches. These figures are based on the average dates of the last occurrence of 32° in spring and the first occurrence of 28° in fall. The following shows the rate of potential evapotranspiration for each month.

	Inches		*Inches*
January	0.4	July	4.7
February	.9	August	4.4
March	1.3	September	3.4
April	2.1	October	2.2
May	3.1	November	.9
June	3.9	December	.4
		Total	27.7

Water Supply

A report based on investigations by the Washington State Department of Conservation, Division of Water Resources, and the U.S. Geological Survey concluded that yields adequate for irrigation can be obtained from wells in most farmed areas of Clark County. The total available water is sufficient for all foreseeable irrigation needs.

In a few local areas, aquifers are fine grained and yields of individual wells are low.

Enormous ground-water supplies are available from aquifers underlying the flood plain of the Columbia River near Vancouver, Camas, Washougal, and Ridgefield. Small to moderate quantities of water are obtained from fractures in the older consolidated rocks in the areas along the foothills of the Cascades in the eastern part of the county.

The rest of the county is a series of alluvial plains and benches that include most of the farmland in the county. Wells in these areas draw water from sand and gravel strata at depths of less than 300 feet. The highest alluvial bench extends in a slightly northwesterly direction from the Camas-Washougal area to the Lewis River, then west to the vicinity of Woodland. This has been the area of lowest water yield. Domestic wells are weak, and irrigation sources are streams and developed irrigation reservoirs. Wells in the remaining plains and benches (Fourth Plain and Mill Plain, for example) furnish large water supplies. Many of these wells produce in excess of 1,000 gallons per minute. The only exception is in the area northwest of the community of Pioneer, where the aquifer is fine grained. Streams and developed irrigation reservoirs are used.

Domestic and stock use of ground water in the county is estimated to be 3.6 million gallons per day., Public supply systems use an average of about 9 million gallons per day, of which more than 7 million gallons is ground water obtained from springs and wells. Industrial use of ground water, concentrated in the vicinity of Vancouver and Camas, is about 75 million gallons per day.

Records of the Washington State Department of Conservation, Division of Water Resources, show that 137 farms were irrigated from wells in 1955. More than 3,000 acres of farmland were irrigated.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Ash, volcanic. Small particles of solid or porous fragments of obsidian or pumice that look like coarse ashes, ejected in volcanic activity.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. The ratings and the approximate amount of water for each are as follows : very high, 10 inches or more; high, 7.5 inches to 10 inches; moderately high, 5 inches to 7.5 inches; moderate, 3.75 to 5 inches ; low, 2 inches to 3.75 inches ; very low, less than 2 inches.

Bottom land. Low land formed by alluvial deposits along a stream or in a lake basin ; a flood plain.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or parallel to the terrace grade.

Diatomaceous earth. Accumulation of the siliceous capsules, or skeletons of diatoms, which are minute, one-celled organisms. It is composed mainly of silica, papery gray to white in color, and it has a high porosity.

Drainage, soil. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A horizon and upper part of the B horizon and have mottling in the lower part of the B horizon and in the C horizon.

Somewhat poorly drained soils are wet for significant periods but not all the time. If Podzolic, they commonly have mottlings to a depth below 6 to 16 inches, in the lower part of the A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods ; they are light gray and generally mottled from the surface downward, but some have few or no mottles.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose.-Noncoherent when dry or moist ; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump ; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material, lad tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger. Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard and brittle ; little affected by moistening.

Fragipan. A loamy, brittle subsurface horizon that is very low in organic matter and clay but is rich in silt or very line sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick ; they generally occur below the B horizon, 15 to 40 inches below the surface.

Gravel. Rounded and subrounded fragments of rocks greater than 2 millimeters but less than 3 inches in diameter. Refers to a mass of fragments.

Green manure (agronomy). A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

Mineral soil. Soil composed mainly of inorganic (mineral) material that has a relatively low content of organic material. Its bulk density is normally greater than that of organic soil.

Horizon, soil. A layer of soil, approximately para111 to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons :

0 horizon.-The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.-The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or m ore of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A horizon to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these ; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon ; or (4) by some combi nation of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.-The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows Abundance-few, *common,* and *many;* size-*fine*, *medium,* and *coarse;* and contrast-faint, *distinct,* and *prominent.* The size measurements are these : *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension ; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension ; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Muck. Fairly well decomposed organic soil material that is relatively high in mineral content and dark in color. Muck accumulates under conditions of impaired drainage.

Organic soil. A general term applied to a soil or to a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers. In chemistry, organic refers to the compounds of carbon.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Perched water table. A layer of saturation in the soil, separated from the true ground water table and held above it by a layer of very slowly permeable or impervious material.

Permeability. The quality of a soil horizon that enables water or air to move through it. Term used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour" soil is one that gives an acid reaction ; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Sand. As a soil separate, individual rock or mineral fragments ranging from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter) in diameter. As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other

plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are-*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or *(2) massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or *"very* fine."