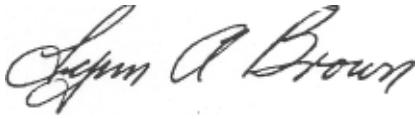
foreword

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

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

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

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



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Location of Yakima County Area in Washington.

soil survey of
Yakima County Area, Washington

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Washington State University, Agriculture Research Center;
and United States Department of the Interior, Bureau of Indian Affairs

YAKIMA COUNTY AREA is in the south-central part of Washington. It consists of privately owned land; land managed by the Forest Service, Bureau of Land Management, the Washington State Department of Game, and the Washington State Department of Natural Resources; and some Yakima Indian Reservation land.

The survey area has a total land area of about 1,394 square miles, or 892,136 acres. About 268,880 acres is irrigated cropland, 64,000 acres is nonirrigated cropland, 425,456 acres is rangeland, 133,800 acres is grazable woodland. Irrigated farming is the main economic enterprise in the area. The major crops include apples, cherries, hops, asparagus, corn, and grass and legumes grown for hay and pasture.

About 65 different kinds of soil are in the survey area. The soils formed in alluvium, eolian sand, lake sediment, loess, and residuum derived from basalt and sandstone. Most of the soils are well drained; however, in some of the lower lying areas drainage is impeded and some of the soils are affected by excessive salts or alkali, or both. The soils are sandy to clayey in texture and are very shallow to very deep. In irrigated areas the soils are dominantly nearly level to strongly sloping. In nonirrigated areas the soils are dominantly moderately steep to steep.

An older survey of Yakima County was published in 1958 (19). It included most of the present survey area. The present survey updates the older survey and provides additional information and orthophoto maps that show the soils in greater detail.

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

general nature of the survey area

This section gives general information about the survey area. It discusses the history and development, physiography, geology, drainage and water supply, and climate.

history and development

Before the arrival of white settlers, the survey area was occupied by the seminomadic Yakima Indians (26). The land was used for camping, hunting, fishing, and gathering of food. As the area became settled, a Roman

Catholic mission was established in the Ahtanum Valley in 1852 and irrigated farming was introduced.

Yakima County was established in 1865. Raising livestock was the main economic activity until the Northern Pacific Transcontinental Railroad was extended into the area in 1886. Large investments were then made in irrigation to attract settlers. By 1900, with construction of the Sunnyside and Congdon Canal systems, Yakima Valley contained the largest irrigated acreage in Washington. The population in the county was centered around the market towns of Yakima, Union Gap, and Sunnyside.

At present Yakima County is among the leading agricultural counties in the United States. It ranks first in the nation in the production of hops, apples, mint, peas for processing, honey, and several kinds of tree fruit. It is also a major center for the production of beef cattle. Also within the survey area are sheep operations, turkey farms, and dairy farms.

physiography

The central and eastern parts of the survey area are in the Walla Walla section of the Columbia Plateau physiographic province (10). These parts of the area are composed of five east-trending ridges formally named Umptanum, Yakima, and Rattlesnake Ridges; Cleman Mountain; and Horse Heaven Hills. In general, the ridges have even crests and smooth sides. Most are not forested and are used primarily as rangeland. The Horse Heaven Hills, in the southeastern part of the area, are predominantly used for nonirrigated crops, mainly winter wheat. Between the ridges are basin valleys that are tributary to the Yakima Valley. These include the Wenas, Naches, Moxee, and Ahtanum Valleys. These valleys are quite extensive and are the main areas used for irrigated crops.

The place where the Yakima River flows between Ahtanum Ridge and Rattlesnake Ridge is known as Union Gap. It serves as a natural divide between the upper and the lower parts of Yakima Valley. The ridges and valleys, along with the lower lying foothills in the western part of the survey area, flank forested foothills and mountains in the far western part of the area. This part of the area is in the middle section of the Cascade Range.

geology

The geology of the survey area is quite varied. The mountainous areas in the western part consist of many different types of rock, including basalt and andesite. Representative soils that formed in loess mixed with material derived from basalt and in residuum and colluvium in these areas are those of the Jumpe, Sutkin, Sapkin, and Naxing series. The principal rock in the central and eastern parts is Yakima Basalt, which is the younger flow of Columbia River Basalt (7). This basalt originated from large fissures or rifts along which the fluid lava swelled to the surface and spread in all directions. Soils such as those in the Ritzville, Starbuck, Shano, and Bickleton series formed in areas where loess is underlain by basalt. Soils such as those in the Bakeoven, Lickskillet, Kiona, McDaniel, and Rock Creek series formed in colluvium and residuum derived from basalt.

Overlying the Yakima Basalt in many areas that flank foothills and ridges are the light-colored tuffaceous sandstone, siltstone, and conglomerate of the Ellensburg Formation. This old stream-deposited sediment was derived from volcanic material ejected during the early development of the Cascade Range. The Formation occurs extensively in the Wenas Valley, in the lower reaches of the Naches Valley, in areas west of Yakima, and along the southern part of Rattlesnake Ridge. The Formation is more than 1,800 feet thick in places. Soils that formed in loess mixed with material derived from the Ellensburg Formation are those of the Harwood, Gorst, Cowiche, and Taneum series.

Subsequent folding of the basalt has formed the series of east-trending ridges. The Ellensburg Formation was deposited during the early stages of basalt folding; therefore, it is on highly dissected terraces. The uplifting of these folds was so slow that the Yakima River was able to downcut rapidly enough to maintain its course. The tributaries to the Yakima River formed as a result of the basalt folding. In a few areas of the Wenas Valley and near Pamona, the Ellensburg Formation is capped by a late lava flow.

The upper and lower parts of Yakima Valley have been filled with material that was deposited by normal stream activity and glacial outwash. These areas include low terraces and flood plains. Representative soils that formed in recent alluvium are those in the Esquatzel, Weirman, Ashue, Wenas, Toppenish, and Umapine series. Extensive areas in the lower part of Yakima Valley are mantled by loess underlain by lake sediment that was deposited during glacial flooding in the late Pleistocene. This sediment occurs at elevations of as much as 1,000 feet in the survey area. Warden soils are examples of soils that formed in loess overlying lake sediment. These are the most extensive soils in the survey area.

drainage and water supply

Almost all of the survey area drains into the Yakima River; however, the far northeastern and southeastern parts drain into the Columbia River.

The supply of irrigation water comes primarily from streams that receive snowmelt from the Cascade Range. These streams have more than ample flow early in the growing season, but the flow decreases during the season. To supplement the flow of the streams in summer and fall, three large mountain lakes have been

dammed to create storage reservoirs. These are the Cle Elum, Kachess, and Keechelus Lakes, which are in Kittitas County. Three other reservoirs, Tieton and Clear Lakes on the Tieton River and Bumping Lake on the Bumping River, are in Yakima County, and they greatly increase the flow of the Naches River. There is also a small reservoir in the Wenas Valley. Even with these reservoirs, there is frequently a shortage of water in tributaries of the Yakima River. Transmission losses and overirrigation aggravate the problems of water shortage, drainage, erosion, and alkali and salt accumulation.

All available surface water presently is allocated to irrigated land. Development of more irrigated land will require additional storage capacity, more underground sources of water, or use of water-saving measures within present allocations. There appears to be potential for developing more irrigated land above the Roza Canal in the Moxee Valley and the south flanks of Rattlesnake Ridge. Other areas have little or no potential for irrigation because of the limited productivity of the soils and the high cost of obtaining water.

climate

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

The Rocky Mountains partly shield the Yakima County Area from strong arctic winds, so winters, though cold, generally are not too severe. In summer Pacific Ocean winds are partially blocked; the days are hot, but the nights are fairly cool. Precipitation, except in mountainous areas, is scant in summer. In many places, however, it is adequate during the cooler parts of the year for growing nonirrigated small grain and range plants. The snowpack accumulation at high elevations supplies irrigation water for intensive farming in some of the lowland areas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Yakima and Sunnyside in the period 1951-78 and at Rimrock in the period 1951-77. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperatures at Yakima, Rimrock, and Sunnyside are 32, 29, and 35 degrees F, respectively. The average daily minimum temperature is 23 degrees at Yakima, 21 degrees at Rimrock, and 26 degrees at Sunnyside. The lowest temperature on record, which occurred at Yakima on February 1, 1956, at Rimrock on December 17, 1964, and at Sunnyside on January 26, 1957, is -20 degrees. In summer the average temperature is 68 degrees at Yakima, 61 degrees at Rimrock, and 70 degrees at Sunnyside. The average daily maximum temperature is about 82 degrees F. The highest recorded temperature, which occurred at Yakima on August 10, 1971, is 110 degrees.

Growing degree days, shown in table 1, are equivalent to heat units. During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The temperature at which a crop ceases to grow varies, depending on the crop. A base temperature of 40 degrees has been arbitrarily chosen to typify the minimum temperature for some crops. The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 7 to 8 inches at Yakima and Sunnyside and 25 inches at Rimrock. Of this, 30 percent at Yakima and Sunnyside and 20 percent at Rimrock usually falls in April through September, which includes the growing season for most crops. The heaviest 1-day rainfall recorded was 2.75 inches at Rimrock on November 20, 1962. Thunderstorms occur on about 7 days each year, and most occur in summer.

The average seasonal snowfall is 25 inches at Yakima, 107 inches at Rimrock, and 12 inches at Sunnyside. The greatest snow depth at any one time during the periods of record was 22 inches at Yakima, 71 inches at Rimrock, and 11 inches at Sunnyside. On the average, 18 days at Yakima, 53 days at Rimrock, and 3 days at Sunnyside have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 40 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 30 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 8 miles per hour, in spring.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

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

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

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

The general soil map at the back of this survey does not join, in all instances, with the general soil maps for adjacent survey areas. Differences in the maps have resulted from differences in the occurrence of soil patterns, differences in the publication scale of the maps, and the recent advances in classification.

The 13 map units in this survey have been grouped into four general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

map unit descriptions

soils on flood plains and terraces

This group consists of four map units. It makes up about 24 percent of the survey area. The soils in this group are nearly level to moderately steep. The native vegetation is mainly grasses, forbs, and shrubs.

The soils in this group are very deep and somewhat excessively drained, well drained, somewhat poorly drained, and artificially drained. They formed in alluvium, eolian sand, and lacustrine sediment and have a mantle of loess or eolian sand.

This group is used mainly for irrigated crops. It is also used for orchards, nonirrigated crops, rangeland, wildlife habitat, and homesites.

1. Umapine-Wenas

Very deep, somewhat poorly drained and artificially drained, nearly level and gently sloping soils; on flood plains

This map unit is in the north-central and eastern parts of the survey area, along the Wenas, Ahtanum, and Yakima Rivers. Slope is 0 to 5 percent. The native vegetation is mainly water- and salt-tolerant grasses and forbs and salt-tolerant shrubs. Elevation is 650 to 1,800 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

This unit makes up about 3 percent of the survey area. It is about 40 percent Umapine soils and 10 percent Wenas soils. The remaining 50 percent is components of minor extent.

Umapine soils are very deep and somewhat poorly drained. They formed in alluvium. These soils are silt loam throughout and are saline and alkaline.

Wenas soils are very deep and artificially drained. They formed in alluvium. The surface layer is silt loam. The upper part of the subsoil is silt loam, and the lower part is silty clay loam. The upper part of the substratum is loam, and the lower part to a depth of 60 inches or more is loamy sand and gravelly loamy sand.

Of minor extent in this unit are Fiander, Zillah, Toppenish, and Track soils and well drained Esquatzel soils.

This unit is used mainly for irrigated crops. It is also used as rangeland, for wildlife habitat, and as homesites.

This unit is suited to irrigated crops. The main limitation of the Wenas soils is wetness, and the main limitations of the Umapine soils are alkalinity and wetness. Where the Umapine soils are drained, leached of excessive salts, and irrigated, they are suited to such crops as sweet corn, alfalfa, winter wheat, and asparagus.

The production of forage on this unit is limited by the salinity of the Umapine soils.

This unit is well suited to habitat for wildlife such as upland game birds, waterfowl, wading birds, and numerous other birds and mammals.

2. Weirman-Ashue

Very deep, somewhat excessively drained and well drained, nearly level and gently sloping soils; on flood plains and low terraces

This map unit is in the north-central part of the survey area, along the Yakima and Naches Rivers. Slope is 0 to 5 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 14 inches, the average annual air temperature is about 51 degrees F, and the frost-free season is 130 to 180 days.

This unit makes up about 4 percent of the survey area. It is about 50 percent Weirman soils and about 15 percent Ashue soils. The remaining 35 percent is components of minor extent.

Weirman soils are on flood plains and low terraces that are dissected by flood channels in some places. These soils are very deep and somewhat excessively drained. They formed in mixed alluvium. The surface layer is sandy loam. The upper part of the underlying material is loamy fine sand, and the lower part to a depth of 60 inches or more is extremely gravelly sand.

Ashue soils are on low terraces. They are very deep and well drained. They formed in alluvium. The surface layer is loam. The subsoil is very gravelly loam and very gravelly sandy clay loam. The substratum to a depth of 60 inches or more is very gravelly sandy loam and extremely gravelly sand.

This unit is used mainly for irrigated crops. It is also used for orchards, rangeland, wildlife habitat, and homesites.

The main limitations of this unit for irrigated crops are the hazard of soil blowing and low available water capacity. Most crops need frequent applications of irrigation water; however, irrigation is not practical on the Weirman soils that have been channeled by frequent periods of flooding. Irrigated crops grown include corn, grain, grasses, legumes, and tree fruit.

The production of forage on this unit is limited by low available water capacity and, on the Weirman soils, the hazard of flooding.

This unit is well suited to habitat for wildlife such as upland game birds, waterfowl, wading birds, cavity-nesting birds, birds of prey, and a few deer.

The main limitation for homesite development is the hazard of flooding on the Weirman soils. If the Ashue soils are used for septic tank absorption fields, seepage is a concern.

3. Quincy-Hezel

Very deep, somewhat excessively drained, nearly level to moderately steep soils, on terraces

This map unit is in the eastern part of the survey area, in the vicinity of Sunnyside. Slope is 0 to 15 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the frost-free season is 135 to 180 days.

This unit makes up about 1 percent of the survey area. It is about 45 percent Quincy soils and 35 percent Hezel soils. The remaining 20 percent is components of minor extent.

Quincy soils are very deep and somewhat excessively drained. They formed in eolian sand. These soils are loamy fine sand throughout.

Hezel soils are very deep and somewhat excessively drained. They formed in lacustrine sediment and have a mantle of eolian sand. The surface layer is loamy fine sand. The underlying material to a depth of 60 inches or more is stratified loamy fine sand, very fine sandy loam, and silt loam.

Of minor extent in this unit are well drained Cleman, Esquatzel, and Warden soils and poorly drained Wander soils.

This unit is used mainly for irrigated field crops and orchards. It is also used as rangeland, for wildlife habitat, and as homesites.

The main limitations of this unit for irrigated crops are the low available water capacity and the hazard of soil blowing, which makes tillage management important. Irrigated crops grown include grain, corn, and potatoes. Grasses and legumes are grown for hay, pasture, and seed.

The production of forage on this unit is limited by low available water capacity.

This unit provides habitat for some game birds such as pheasant, dove, and quail.

The main limitation of this unit for homesite development is the hazard of soil blowing during construction. Construction sites should be disturbed as little as possible. The Hezel soils are moderately slowly permeable, which affects the rate of absorption of effluent from septic tank absorption fields. If the density of housing is moderate to high, community sewage systems are needed on the Quincy soils to prevent contamination of water supplies as a result of seepage from septic tank absorption fields.

4. Warden-Esquatzel

Very deep, well drained, nearly level to moderately steep soils; on terraces and flood plains

This map unit is in the east-central part of the survey area, east of Yakima and in the vicinity of Moxee. Slope is 0 to 30 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,500 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the frost-free season is 135 to 180 days.

This unit makes up about 16 percent of the survey area. It is about 60 percent Warden soils and about 20

percent Esquatzel soils. The remaining 20 percent is components of minor extent.

Warden soils are on terraces. These soils are very deep and well drained. They formed in lacustrine sediment and have a mantle of loess. The surface layer and subsoil are silt loam. The substratum to a depth of 60 inches or more is stratified silt loam and very fine sandy loam.

Esquatzel soils are on flood plains. These soils are very deep and well drained. They formed in silty alluvium. These soils are silt loam throughout.

Of minor extent in this unit are Burke, Cleman, Finley, Ritzville, Scion, Smoothened, and Shano soils. Also included are somewhat poorly drained Outlook and Sin loc soils and somewhat excessively drained Quincy soils.

This unit is used mainly for irrigated crops. It is also used for orchards, nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitation of this unit for irrigated crops is the hazard of soil blowing. Proper irrigation water management is needed to prevent overirrigation and subsequent development of saline and alkaline seeps. A wide variety of irrigated crops can be grown, including asparagus, corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for nonirrigated crops are the low annual precipitation and the hazards of soil blowing and water erosion. The soil in this unit generally is too dry for annual cropping; however, it is well suited to the production of winter wheat if a summer fallow cropping system is used.

The production of forage on this unit is limited by the low annual precipitation. Proper grazing use combined with a deferred-rotation grazing system is the most effective and least expensive method of range improvement.

This unit is suited to habitat for game birds such as dove, pheasant, and quail.

The main limitations of this unit for homesite development are the hazard of flooding on the Esquatzel soils and the areas of the Warden soils that have slopes of more than 15 percent. If these areas are used for septic tank absorption fields, slope may cause lateral seepage and surfacing of effluent in down slope areas.

soils on high dissected terraces

This group consists of one map unit. It makes up about 8 percent of the survey area. The soils in this group are nearly level to steep. The native vegetation is mainly grasses, forbs, and shrubs.

The soils in this group are shallow and moderately deep and are well drained. They formed in loess and old alluvium and are underlain by a lime- and silica cemented pan in some areas.

This group is used mainly for irrigated field and orchard crops. It is also used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

5. Harwood-Gorst-Selah

Moderately deep and shallow, well drained, nearly level to steep soils; on high dissected terraces

This map unit is in the central part of the survey area, west of Selah and Yakima, north of the Wenas Valley, and along the south flanks of Rattlesnake Ridge. Slope is 0 to 60 percent The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,100 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the frost-free season is 135 to 180 days.

This unit makes up about 8 percent of the survey area. It is about 35 percent Harwood soils, 20 percent Gorst soils, and 10 percent Selah soils. The remaining 35 percent is components of minor extent.

Harwood soils are moderately deep and well drained. They formed in loess and old alluvium. The surface layer and subsoil are loam. The substratum is gravelly loam. A cemented pan is at a depth of about 30 inches.

Gorst soils are shallow and well drained. They formed in loess and old alluvium. These soils are loam. A cemented pan is at a depth of about 15 inches.

Selah soils are moderately deep and well drained. They formed in loess and old alluvium. The surface layer and the upper part of the subsoil are silt loam. The lower part of the subsoil is silty clay loam or clay loam. A lime- and silica-cemented pan is at a depth of about 34 inches.

Of minor extent in this unit are Cowiche, Esquatzel, Gorskel, Logy, Ritzville, Rock Creek, Roza, Selah, and Willis soils.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitation of this unit for irrigated crops is depth to the cemented pan in the Gorst soils. Soil depth and steepness of slope make irrigation water management important. The Gorst soils are suited to permanent crops such as grasses and legumes and to orchards with perennial cover crops. The Harwood soils are suited to orchards and to crops such as corn, grain, grapes, peas, grasses, and legumes. The Selah soils are suited to orchards and to crops such as grain, grasses, and legumes.

The Harwood soils are suited to nonirrigated crops such as winter wheat if a summer fallow cropping system is used.

The production of forage on this unit is limited by low available water capacity and low annual precipitation. Proper grazing use combined with a deferred-rotation grazing system is the most effective and least expensive method of range management.

This unit is suited to habitat for game birds, including dove, pheasant, and quail.

The main limitations of this unit for use as homesites are depth to the cemented pan of the Gorst soils and the areas that have slopes of more than 15 percent. The pan hinders excavation. If the unit is used for septic tank absorption fields, slope can cause lateral seepage and surfacing of effluent in downslope areas.

soils on uplands, ridgetops, and plateaus

This group consists of six map units. It makes up about 45 percent of the survey area. The soils in this group are nearly level to steep. The native vegetation is mainly grasses, forbs, and shrubs.

The soils in this group are very shallow to very deep and are well drained. They formed in loess, in residuum and colluvium derived from basalt, andesite, or sandstone, and in material derived from fine-textured sediment.

This group is used mainly for nonirrigated crops and as rangeland. It is also used for irrigated field and orchard crops, irrigated hay and pasture, wildlife habitat, and homesites.

6. Lickskillet-Starbuck

Shallow, well drained, nearly level to steep soils; on uplands

This map unit is in the northeastern part of the survey area, on Rattlesnake and Yakima Ridges, and along the eastern part of the area, near Byron. Slope is 0 to 60 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 3,200 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is about 49 degrees F, and the frost-free season is 120 to 170 days.

This unit makes up about 9 percent of the survey area. It is about 35 percent Lickskillet soils and 15 percent Starbuck soils. The remaining 50 percent is components of minor extent.

Lickskillet soils formed in loess and in residuum and colluvium derived from basalt. The surface layer is silt loam or very stony silt loam. The subsoil is very gravelly silt loam, very gravelly loam, or very cobbly loam. Basalt is at a depth of about 20 inches. Depth to basalt ranges from 12 to 20 inches.

Starbuck soils formed in loess. The surface layer and the upper part of the subsoil are silt loam. The lower part of the subsoil is gravelly silt loam. Basalt is at a depth of about 16 inches. Depth to basalt ranges from 12 to 20 inches.

Of minor extent in this unit are Bakeoven, Bickleton, Cowiche, Esquatzel, Harwood, Kiona, Moxee, Renslow, Ritzville, Selah, Simcoe, and Willis soils and Rock outcrop.

This unit is used mainly as rangeland. It is also used for irrigated crops, for wildlife habitat, and as homesites.

The production of forage on this unit is limited by low available water capacity and low annual precipitation.

The main limitations of this unit for irrigated crops are the shallow depth to bedrock and steepness of slope, which make proper irrigation water management important.

This unit is well suited to habitat for game birds such as chukar and quail and for deer and bighorn sheep.

The main limitations of this unit for homesite development are the shallow depth to rock and the areas that have slopes of more than 15 percent. The rock hinders excavation. If this unit is used for septic tank absorption fields, the shallow depth to rock limits the absorption capacity of the soils and slope can cause lateral seepage and surfacing of effluent in downslope areas.

7. Willis-Moxee

Moderately deep and shallow, well drained, nearly level to moderately steep soils; on uplands

This map unit is in the northeastern part of the survey area, along the southern flanks of Yakima and Rattlesnake Ridges. Slope is 0 to 30 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 49 degrees F, and the frost-free season is 125 to 160 days.

This unit makes up about 8 percent of the survey area. It is about 35 percent Willis soils and 15 percent Moxee soils. The remaining 50 percent is components of minor extent.

Willis soils are moderately deep and well drained. They formed in loess. The surface layer is fine sandy loam or silt loam. The subsoil and substratum are silt loam. A lime- and silica-cemented pan is at a depth of about 34 inches. Depth to the pan ranges from 20 to 40 inches.

Moxee soils are shallow and well drained. They formed in loess. The surface layer and subsoil are silt loam. The substratum is gravelly silt loam. A lime- and silica-cemented pan is at a depth of about 18 inches. Depth to the pan ranges from 10 to 20 inches.

Of minor extent in this unit are Cowiche, Finley, Ritzville, Scooteney, and Starbuck soils.

This unit is used for irrigated crops, irrigated hay and pasture, nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitation of this unit for irrigated crops are depth to a cemented pan and steepness of slope, which make irrigation water management important. The Moxee soils are suited to permanent crops such as grasses and legumes and to orchards with perennial cover crops. The Willis soils are suited to orchards and to crops such as corn, grain, grapes, peas, grasses, and legumes.

The main limitations of this unit for nonirrigated crops are low annual precipitation and the hazard of water erosion. The Willis soils are suited to the production of winter wheat if a summer fallow cropping system is used.

The production of forage is limited by low annual precipitation and low available water capacity. Proper grazing use along with a deferred-rotation grazing system is the most effective and least expensive method of range management.

This unit is suited to habitat for game birds such as dove, pheasant, and quail.

The main limitations of this unit for use as homesites are depth to the cemented pan and the areas that have slopes of more than 15 percent. The pan hinders excavation. The shallow and moderate depth of the soils in this unit limits the capacity of septic tank absorption fields. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

8. Ritzville-Starbuck

Very deep, deep, and shallow, well drained, nearly level to steep soils; on uplands

The map unit is mainly on Horse Heaven Hills and in Moxee Valley. A few areas of the unit are west of Yakima, west of Selah, and on the northwestern end of Rattlesnake Ridge. Slope is 0 to 60 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 2,500 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is about 49 degrees F, and the frost- free season is 130 to 170 days.

This unit makes up about 12 percent of the survey area. It is about 75 percent Ritzville soils and 10 percent Starbuck soils. The remaining 15 percent is components of minor extent.

Ritzville soils are deep and very deep and are well drained. They formed in loess. The soils are silt loam to a depth of 60 inches or more.

Starbuck soils are shallow and well drained. They formed in loess. The surface layer and the upper part of the subsoil are silt loam. The lower part of the subsoil is gravelly silt loam. Basalt is at a depth of about 16 inches. Depth to basalt ranges from 12 to 20 inches.

Of minor extent in this unit are Bickleton, Cowiche, Esquatzel, Kiona, Renslow, Selah, and Willis soils and Rock outcrop.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations of this unit for irrigated crops are depth to rock in the Starbuck soils and a hazard of water erosion. Depth to rock and steepness of slope make irrigation water management important. The Starbuck soils generally are suited to permanent crops such as grasses and legumes and to orchards with cover crops. Crops commonly grown on the Ritzville soils include grain, corn, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation of the Ritzville soils for use as nonirrigated cropland is low annual precipitation. These soils are well suited to the production of winter wheat if a summer fallow cropping system is used. Starbuck soils are not used for nonirrigated crops.

The production of forage on the Starbuck soils is limited by low available water capacity. The Ritzville soils are well suited to the production of forage.

This unit provides habitat for game birds such as pheasant, quail, and dove.

The main limitation of the Starbuck soils for use as homesites is depth to rock, which hinders excavation. The Ritzville soils have few limitations. If the soils in this unit are used for septic tank absorption fields, steepness of slope can cause lateral seepage and surfacing of effluent in downslope areas.

9. Taneum-Tieton

Deep and very deep, well drained, nearly level to steep, moist soils; on uplands

This map unit is in the northern part of the Wenas Valley and in the vicinity of Tieton and Cowiche. Slope is 0 to 60 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 3,000 feet. The average annual air temperature is about 49 degrees F, the average annual precipitation is 11 to 18 inches, and the frost-free season is 120 to 150 days.

This unit makes up about 4 percent of the survey area. It is about 40 percent Taneum soils and 40 percent Tieton soils. The remaining 20 percent is components of minor extent.

Taneum soils are very deep and well drained. They formed in loess overlying weathered sandstone. The surface layer is loam. The subsoil is silty clay loam or clay loam. The substratum to a depth of 60 inches or more is loam or sandy loam.

Tieton soils are deep and well drained. They formed in loess and in material weathered from andesite. The surface layer is fine sandy loam or loam. The subsoil is loam, silty clay loam, or clay loam. The substratum is loam. Weathered andesite is at a depth of about 50 inches. Depth to andesite ranges from 40 to 60 inches.

Of minor extent in this unit are Clint, Esquatzel, Logy, McDaniel, Meystre, Rock Creek, and Roza soils.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites.

The Tieton soils are suited to irrigated crops. The main limitations are a hazard of soil blowing in areas that have a fine sandy loam surface layer and a hazard of water erosion in areas that have a loam surface layer. Crops grown include tree fruit, grain, and grapes. Grasses and legumes are also grown for hay and pasture. The main

limitation of the soils for growing tree fruit is the length of the growing season. The Taneum soils generally are not irrigated.

This unit is suited to nonirrigated crops. The main limitation is low annual precipitation. The soils in this unit are suited to the production of winter wheat in rotation with summer fallow and spring barley.

This unit is well suited to use as rangeland. Most of the areas of rangeland are on the Taneum soils.

This unit is well suited to habitat for game birds such as pheasant, quail, and dove and for deer and elk.

The main limitations of this unit for use as homesites are shrink-swell potential and the areas that have slopes of more than 15 percent. If the unit is used for septic tank absorption fields, slope can cause lateral seepage and surfacing of effluent in downslope areas.

10. Rock Creek-McDaniel

Very shallow and very deep, well drained, nearly level to steep soils, on plateaus and ridgetops on uplands

This unit is in the northwestern part of the survey area. Slope is 0 to 65 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 3,300 feet. The average annual precipitation is 12 to 18 inches, the average annual air temperature is about 49 degrees F, and the frost-free season is 120 to 170 days.

This unit makes up about 9 percent of the survey area. It is about 55 percent Rock Creek soils and 20 percent McDaniel soils. The remaining 25 percent is components of minor extent.

Rock Creek soils are on plateaus and ridgetops on uplands. These soils are very shallow and well drained. They formed in loess and in residuum derived from basalt. The surface layer is very stony silt loam. The subsoil is very cobbly clay. Basalt is at a depth of about 10 inches. Depth to basalt ranges from 8 to 15 inches.

McDaniel soils are on uplands. These soils are very deep and well drained. They formed in loess and in colluvium derived from basalt. The surface layer is very stony loam. The underlying material to a depth of 60 inches or more is very gravelly clay loam, very cobbly silty clay loam, or extremely cobbly silty clay loam.

Of minor extent in this unit are Clint, Esquatzel, Logy, Meystre, Roza, and Taneum soils.

This unit is used as rangeland, for wildlife habitat, and as homesites.

The production of forage on the Rock Creek soils is limited by low available water capacity. The McDaniel soils are well suited to use as rangeland. Seeding is difficult because of stones on the surface. Proper grazing use and periodic rest of areas of rangeland are the most effective and least expensive methods of range management and erosion control.

This unit is well suited to habitat for deer, elk, bighorn sheep, and game birds such as chukar and pheasant.

The main limitations for homesites on the Rock Creek soils are the very shallow depth to bedrock, large stones, and the areas that have slopes of more than 15 percent. The bedrock hinders excavation. The presence of large stones can interfere with the operation of equipment and the installation of absorption lines. The McDaniel soils generally are not used as homesites.

11. Cowiche-Roza

Very deep, well drained, nearly level to steep soils; on uplands

This map unit is in the north-central part of the survey area, on the north and south sides of the Wenas Valley and northwest of Selah. Slope is 2 to 60 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual air temperature is about 50 degrees F, the average annual precipitation is 8 to 12 inches, and the frost-free season is 135 to 160 days.

This unit makes up about 3 percent of the survey area. It is about 40 percent Cowiche soils and 35 percent Roza soils. The remaining 25 percent is components of minor extent.

Cowiche soils formed in residuum derived from sandstone and have a mantle of loess. The surface layer and subsoil are loam. The upper part of the substratum is very fine sandy loam, and the lower part to a depth of 60 inches or more is loamy fine sand.

Roza soils formed in material derived from fine-textured sediment. The surface layer is clay loam. The subsoil is clay loam or silty clay. The substratum to a depth of 60 inches or more is silty clay, silty clay loam, or clay loam.

Of minor extent in this unit are Cleman, Gorst, Harwood, Logy, Rock Creek, and Taneum soils and Torriorthents.

This unit is used mainly as rangeland and for wildlife habitat. Some areas are used for irrigated and nonirrigated crops and as homesites.

This unit is suited to use as rangeland. Proper grazing use and periodic rest of the areas of rangeland are the most effective methods of range management and erosion control. Range seeding is a suitable practice if the range vegetation is in poor condition.

This unit is suited to habitat for game birds such as chukar, quail, and pheasant and for deer and elk.

The main limitations of this unit for irrigated crops are steepness of slope, a hazard of water erosion on the Cowiche soils, and the slow permeability of the Roza soils. Proper irrigation water management is needed to prevent overirrigation and reduce the risk of water erosion. Applications of irrigation water should be adjusted to the slow permeability of the Roza soils.

The Cowiche soils are suited to nonirrigated crops. The average annual precipitation is too low for annual cropping; however, the soils are suited to the production of winter wheat if a summer fallow cropping system is used.

The main limitations of this unit for use as homesites are the shrink-swell potential and slow permeability of the Roza soils. If the unit is used for septic tank absorption fields, steepness of slope in places can cause lateral seepage and surfacing of effluent in downslope areas.

soils on uplands and mountains and in canyons

This group consists of two map units. It makes up about 23 percent of the survey area. The soils in this group are nearly level to very steep. The native vegetation is mainly conifers, grasses, forbs, and shrubs.

The soils in this group are moderately deep and very deep and are well drained. They formed in residuum and colluvium derived from basalt and containing loess and volcanic ash.

This group is used mainly as grazable woodland and rangeland and for wildlife habitat.

12. Jumpe-Sutkin-Sapkin

Very deep and moderately deep, well drained, nearly level to very steep soils; on uplands, mountainsides, and smooth mountaintops, in canyons, and on long, broad ridges

This map unit is in the western part of the survey area. Slope is 0 to 75 percent. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,400 to 5,800 feet. The average annual precipitation is 18 to 40 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 95 to 130 days.

This unit makes up about 18 percent of the survey area. It is about 35 percent Jumpe soils, 20 percent Sutkin soils, and 20 percent Sapkin soils. The remaining 25 percent is components of minor extent.

Jumpe soils are on mountainsides, on long, broad ridges, and in canyons. These soils are very deep and well drained. They formed in residuum and colluvium derived from basalt and containing a minor amount of loess and volcanic ash. The surface layer is stony loam. The subsoil and substratum to a depth of 60 inches or more are extremely cobbly loam.

Sutkin soils are on mountainsides and in canyons. They are very deep and well drained. They formed in colluvium and residuum derived from basalt and containing a minor amount of loess. The surface layer is stony loam. The subsoil is very cobbly loam or extremely cobbly loam. The substratum to a depth of 60 inches or more is cobbly loam.

Sapkin soils are on uplands and mountainsides. These soils are moderately deep and well drained. They formed in colluvium and residuum derived from basalt and containing a minor amount of loess. The surface layer is very stony loam or loam. The subsoil is cobbly loam, very cobbly loam, or extremely cobbly clay loam. Basalt is at a depth of about 27 inches. Depth to basalt ranges from 20 to 40 inches.

Of minor extent in this unit are Bocker, Carmack, Loneridge, Mippon, and Tekison soils and areas of Rubble land and Rock outcrop.

This unit is used as grazable woodland and for wildlife habitat.

The Jumpe and Sutkin soils in this unit are suited to the production of Douglas-fir and ponderosa pine. Douglas-fir is the dominant species on the Jumpe soils, and ponderosa pine is the dominant species on the Sutkin soils. The areas of Rubble land and Rock outcrop can hinder harvesting. Use of conventional methods of harvesting trees may be difficult in the steeper areas.

The Sapkin soils are well suited to the production of forage, but the production of forage is low on the Jumpe and Sutkin soils. The forage can be improved by seeding adapted species. The presence of logging debris limits seeding.

This unit is well suited to use as habitat for elk, deer, and bighorn sheep.

13. Naxing-Darland

Very deep, well drained, gently sloping to very steep soils; on mountains and broad ridges

This map unit is in the western part of the survey area. Slope is 5 to 75 percent. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 5,000 to 7,000 feet. The average annual precipitation is 22 to 50 inches, the average annual air temperature is about 41 degrees F, and the average growing season, at 28 degrees F, is 80 to 120 days.

This unit makes up about 5 percent of the survey area. It is about 45 percent Naxing soils and 10 percent Darland soils. The remaining 45 percent is components of minor extent.

Naxing soils are on mountains and broad ridges. These soils formed in colluvium derived dominantly from basalt, volcanic ash, and loess. The surface layer is stony loam or loam. The subsoil is very cobbly loam. The substratum to a depth of 60 inches or more is extremely cobbly loam.

Darland soils are on south-facing mountainsides. These soils formed in colluvium derived from basalt. The surface layer is stony loam, very gravelly loam, or very cobbly loam. The subsoil is extremely cobbly loam. The substratum to a depth of 60 inches or more is extremely cobbly sandy loam.

Of minor extent in this unit are Tumac soils, Cryumbrepts, moderately well drained Saydab soils, and Aquic Cryandepts.

This unit is used as grazable woodland, as rangeland, and for wildlife habitat.

The Naxing soils are suited to the production of subalpine fir, western larch, lodgepole pine, and Engelmann spruce; however, stands of merchantable

timber are not produced on these soils. The large amount of volcanic ash in the soils increases the risk of erosion and results in low load-bearing strength. Additions of coarse base rock are needed for roads.

The Darland soils are not forested and are suited to the production of forage. The main limitations are the short growing season, steepness of slope, and stones on the surface. Steepness of slope limits accessibility. The production of forage on the Naxing soils is limited by the density of the overstory canopy and the short growing season. The presence of logging debris limits seeding.

This unit is well suited to habitat for bears and other mammals and to summer range for deer and elk.

broad land use considerations

The soils in this survey area have potential for a variety of uses such as irrigated cropland, orchards, nonirrigated cropland, rangeland, grazable woodland, wildlife habitat, homesite development, and recreation.

Approximately 30 percent of the acreage in the survey area is used as irrigated cropland. The major crops grown include apples, cherries, hops, asparagus, and corn. Grasses and legumes are grown for hay, pasture, and seed. The areas of cropland are primarily in valleys in general map units 1, 2, 3, 4, 5, 7, and 8. The Lickskillet and Starbuck soils in map unit 6 are shallow and are suited to permanent pasture or to orchards with a perennial cover crop. The Ritzville soils in map unit 8 are well suited to irrigated crops if irrigation water is available. The main limitation is the hazard of erosion. The Tieton soils in map unit 9 are also used for irrigated crops.

The soils in map unit 1 have a seasonal high water table, are subject to flooding, and are affected by salts or alkali in some areas. Installing adequate drains and leaching excess salts may be needed to achieve optimum yields. The soils in map unit 2 have low available water capacity, and frequent applications of irrigation water are needed. The soils in map unit 3 are sandy and are subject to a high hazard of wind erosion. Frequent applications of irrigation water are needed to reduce soil blowing and to satisfy crop needs. Map unit 4 is the largest and best suited unit for use as irrigated cropland. It consists mainly of Warden soils. The hazard of erosion is the main limitation in map units 4, 5, 7, and 8. Soils that are moderately deep or shallow to a hardpan are a concern in map units 5 and 7 because the hardpan is a limitation for the construction of irrigation systems.

About 7 percent of the acreage in the area is used as nonirrigated cropland. The soils in map units 4, 8, and 9 are well suited to a winter wheat-fallow cropping system. These include the Warden, Ritzville, and Taneum soils. The Harwood and Willis soils in map units 5 and 7 are suited to nonirrigated winter wheat but are less productive than the Warden, Ritzville, and Taneum soils.

About 48 percent of the survey area is used as rangeland. Most of the areas of rangeland are on soils in map units 6, 7, 10, and 11. These include the Lickskillet, Willis, Rock Creek, and Roza soils. Soils in most other map units are well suited to use as rangeland, but their characteristics allow them to be used for more intensive purposes. The soils in map units 12 and 13 are forested, but they provide low yields of forage. These include the Jumpe, Sutkin, and Naxing soils.

About 15 percent of the survey area is used as grazable woodland, which is mainly in map units 12 and 13. The Jumpe and Sutkin soils in unit 12 produce good stands of Douglas-fir. The soils in map unit 13 generally are less productive because of the climate.

The soils in all of the map units are suited to wildlife habitat. Wetland and shallow water areas in map units 1 and 2 provide good habitat for waterfowl and wading birds. Map units 3, 4, 5, 6, 7, 8, 9, and 10 provide suitable habitat for upland game birds such as dove, pheasant, and quail. The soils in map units 9, 11, and 12 provide good habitat for big game such as deer, elk, and some bighorn sheep.

Most of the map units are suited to use as homesites. In general, the nearly level to strongly sloping Warden and Ritzville soils in map units 4 and 8 are well suited for use as homesites. Depth to the hardpan or bedrock severely limits the soils in map units 5, 6, and 7 for use as homesites. Map unit 1 is poorly suited because of the hazard of flooding and wetness. The Weirman soils in map unit 2 are also subject to flooding. The Roza soils in map unit 11 are poorly suited for use as homesites because of high shrink-swell potential. In the other map units, steepness of slope, depth to rock, permeability, and stones are the main limitations.

The soils in map units 1 and 2 have low potential for use as recreation sites because of the hazard of flooding. The soils in the other map units have some potential, depending on steepness of slope, soil depth, and the characteristics of the surface layer. Map units 10, 11, and 12 are used most extensively for hiking, horseback riding, cross-country skiing, fishing, hunting, and snowmobiling, The Oak Creek and L. T. Murray Wildlife Recreation Areas and the Darland Loop are in these map units. The Yakima River, north of Selah, is used for boating and rafting.

detailed soil map units

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

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

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

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Warden silt loam, 2 to 5 percent slopes, is one of several phases in the Warden series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A soil complex consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Harwood-Gorst complex, 0 to 25 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

map unit descriptions

1-Aquic Cryandepts, gently sloping. These deep, moderately well drained soils are in swales on alluvial fans and on stream terraces. They formed in alluvium that is derived from basalt and contains some volcanic ash and loess. Slope is 0 to 3 percent. The native vegetation is mainly grasses. Elevation is 4,400 to 6,300 feet. The average annual precipitation is 30 to 50 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 60 to 95 days.

No single profile is typical of Aquic Cryandepts, but one commonly observed in the survey area has a surface layer of dark brown and brown silt loam about 15 inches thick. The subsoil is yellowish brown extremely cobbly silt loam and light yellowish brown very cobbly sandy loam about 16 inches thick. The substratum is yellow very gravelly silt loam about 13 inches thick. Basalt is at a depth of about 44 inches. Depth to basalt ranges from 40 to 60 inches or more.

Included in this unit are areas of poorly drained and somewhat poorly drained soils in depressional areas and some areas of soils that have a clay subsoil. Included areas make up about 15 percent of the total acreage.

Permeability of these Aquic Cryandepts is moderate. Effective rooting depth is 40 to 60 inches or more. Available water capacity is moderate. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as rangeland and for wildlife habitat and recreation.

The present vegetation is mainly bluegrass, fescue, sedges, quaking aspen, and false-hellebore. The production of forage is limited by the short growing

season. Because this unit consists of open meadows interspersed with heavily timbered areas, grazing pressure can be severe. The establishment of salt licks and livestock watering facilities away from the meadows or construction of management fences improves the distribution of grazing by livestock and wildlife and reduces the grazing pressure on the meadows.

Following severe overgrazing, seeding reduces soil erosion, preserves water quality, and increases production. Seeding can be done at any time of the year, but seeding late in summer or in fall is most successful. Soil wetness is the major factor limiting seeding. Broadcast seeding is the most effective method. Adapted grasses and legumes should be seeded on this unit.

This map unit is in capability subclass VIw, nonirrigated.

2-Ashue loam. This very deep, well drained soil is on low terraces. It formed in alluvium. Slope is 0 to 2 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is brown loam about 10 inches thick. The upper part of the subsoil is yellowish brown very gravelly loam about 5 inches thick, and the lower part is yellowish brown very gravelly sandy clay loam about 14 inches thick. The upper part of the substratum is dark yellowish brown very gravelly sandy loam about 5 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown extremely gravelly sand. In some areas the surface layer is cobbly or gravelly.

Included in this unit are small areas of Naches, Weirman, Logy, Zillah, and Yakima soils.

Permeability of this Ashue soil is moderately slow above the extremely gravelly sand part of the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for irrigated field and orchard crops, wildlife habitat, and homesites. The main irrigated crops are corn, grapes, mint, peas, tree fruit, and asparagus. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the low available water capacity. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of irrigation system used generally depends on the kind of crop grown. If surface irrigation is used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content and tilth. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Use of vegetated filter strips at the end of rows reduces the volume of sediment in the tailwater. Exposing the very gravelly part of the substratum when leveling fields should be avoided. Shallow cuts are feasible in some areas.

This unit is poorly suited to homesite development. The main limitation is the content of gravel and large stones. Dustiness can be a problem during construction on large building sites. Building sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Large stones can interfere with the installation of absorption fields.

This map unit is in capability subclass IIIs, irrigated.

3-Bakeoven very cobbly silt loam, 0 to 30 percent slopes. This very shallow, well drained soil is on uplands. It formed in loess and in residuum derived from basalt. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 3,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown very cobbly silt loam about 4 inches thick. The upper part of the subsoil is dark yellowish brown gravelly clay loam about 3 inches thick, and the lower part is dark yellowish brown very gravelly clay loam about 3 inches thick. Basalt is at a depth of about 10 inches. Depth to basalt ranges from 4 to 12 inches. In some areas the surface layer is stony.

Included in this unit are areas of Lickskillet, Moxee, and Starbuck soils.

Permeability of this Bakeoven soil is moderately slow. Available water capacity is low. Effective rooting depth is 4 to 12 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland, for wildlife habitat, and as homesites.

The potential native vegetation on this unit is mainly stiff sagebrush and Sandberg bluegrass. The production of forage is limited by the low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs, sagebrush, and annual grasses increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, chemical treatment, and prescribed burning. Seeding on this unit generally is not practical.

This unit is poorly suited to homesite development. The main limitations are very shallow depth to rock, large stones, and steepness of slope in areas where the slope is more than 15 percent. The very shallow depth to rock hinders excavation.

The main limitations for septic tank absorption fields are large stones, very shallow depth to rock, and steepness of slope. Because of the very shallow depth to rock and steepness of slope, effluent from absorption fields can surface in downslope areas and thus create a hazard to health. Large stones can interfere with the installation of absorption lines.

This map unit is in capability subclass VIIs, nonirrigated.

4-Bickleton silt loam, 0 to 5 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in residuum derived from basalt. The native vegetation is mainly grasses and forbs. Elevation is 2,600 to 3,200 feet. The average annual precipitation is 11 to 14 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 120 to 160 days.

Typically, the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil is brown silt loam about 16 inches thick. The upper part of the substratum is pale brown silt loam about 9 inches thick, and the lower part is calcareous, brown extremely gravelly silty clay loam about 7 inches thick. Basalt is at a depth of about 42 inches. Depth to basalt ranges from 40 to 60 inches. In some areas a thin capping of gravel conglomerate overlies the basalt.

Included in this unit are areas of Renslow and Rock Creek soils and areas of Bickleton soils that have slopes of more than 5 percent.

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

This unit is used for nonirrigated crops, for wildlife habitat, and as rangeland.

The main limitations for nonirrigated crops are the low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable.

Erosion can be reduced by seeding fall grain early, stubble mulching, tilling on the contour or across the slope, and shaping waterways and seeding them to perennial grass. Drop structures are needed in places to control the flow of runoff in waterways. Use of terraces, diversions, and stripcropping, either singly or in combination, is advisable on long slopes.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as Sandberg bluegrass, cheatgrass, big sagebrush, and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, plowing, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass IIIe, nonirrigated.

5-Bickleton silt loam, 5 to 20 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in residuum derived from basalt. Slope is dominantly about 10 percent. The native vegetation is mainly grasses and forbs. Elevation is 2,600 to 3,200 feet. The average annual precipitation is 11 to 14 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 120 to 160 days.

Typically, the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil is brown silt loam about 16 inches thick. The upper part of the substratum is calcareous, pale brown silt loam about 9 inches thick, and the lower part is calcareous, brown extremely gravelly silty clay loam about 7 inches thick. Basalt is at a depth of about 42 inches. Depth to basalt ranges from 40 to 60 inches. In some areas a thin capping of gravel overlies the basalt.

Included in this unit are areas of Renslow and Rock Creek soils and areas of Bickleton soils that have slopes of more than 20 percent.

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

This unit is used for nonirrigated crops and as rangeland.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable.

Erosion can be reduced by seeding fall grain early, stubble mulching, tilling on the contour or across the slope, and shaping waterways and seeding them to perennial grass. Drop structures are needed in places to control the flow of runoff in waterways. Terracing and stripcropping, either singly or in combination, may also be advisable.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. If the range is overgrazed, the proportion of

preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as Sandberg bluegrass, cheatgrass, big sagebrush, and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, plowing, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass IIIe, nonirrigated.

6-Bocker very cobbly loam, 0 to 25 percent slopes. This very shallow, well drained soil is on mountaintops and broad ridgetops. It formed in residuum that is derived from basalt and includes a small amount of loess. The native vegetation is mainly grasses and shrubs. Elevation is 2,800 to 5,500 feet. The average annual precipitation is 18 to 40 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 85 to 130 days.

Typically, the surface layer is dark grayish brown very cobbly loam about 3 inches thick. The subsoil is dark brown very cobbly loam about 4 inches thick. Fractured basalt is at a depth of about 7 inches. Depth to basalt ranges from 5 to 10 inches.

Included in this unit are about 15 percent Sapkin soils on mounds and about 5 percent Jumpe, Sutkin, and Loneridge soils.

Permeability of this Bocker soil is moderate. Available water capacity is low. Effective rooting depth is 5 to 10 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on this unit is mainly Sandberg bluegrass, bottlebrush squirreltail, and eriogonum. The production of forage is limited by cobbles on the surface, very shallow depth to rock, and low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as Sandberg bluegrass and buckwheat decreases and the proportion of less preferred forage plants such as forbs and cheatgrass increases.

This unit is limited for livestock watering ponds and other water impoundments because of the very shallow depth to rock. Water tanks, springs, wells, and pipeline systems can be used to provide water for livestock. Seeding is not feasible because of the cobbles on the surface, low available water capacity, and very shallow soil depth.

This map unit is in capability subclass VIIs, nonirrigated.

7-Bocker-Jumpe complex, 0 to 15 percent slopes. This map unit is on smooth mountaintops and broad ridges. Slope is dominantly 5 percent. The native vegetation is mainly grasses, shrubs, and scattered stands of conifers. Elevation is 3,500 to 5,000 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 85 to 130 days.

This unit is about 60 percent Bocker very cobbly loam and about 35 percent Jumpe stony loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit is about 5 percent Sapkin soils. Also included are areas of Bocker and Jumpe soils that have slopes of more than 15 percent and soils that are 30 to 40 inches deep over basalt.

The Bocker soil is very shallow and well drained. It formed in residuum that is derived from basalt and includes a small amount of loess. Typically, the surface layer is dark grayish brown very cobbly loam about 3 inches thick. The subsoil is dark brown very cobbly loam about 4 inches thick. Fractured basalt is at a depth of about 7 inches. Depth to basalt ranges from 5 to 10 inches.

Permeability of the Bocker soil is moderate. Available water capacity is low. Effective rooting depth is 5 to 10 inches, Runoff is medium, and the hazard of water erosion is moderate.

The Jumpe soil is very deep and well drained. It formed in residuum that is derived from basalt and includes a small amount of loess. Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The surface layer is brown stony loam about 3 inches thick. The subsoil is brown extremely cobbly loam. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam, In some areas the soil has an ashy mantle 4 to 12 inches thick.

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

This unit is used for wildlife habitat and as rangeland and grazable woodland.

Ponderosa pine and Douglas-fir are the main woodland species on the Jumpe soil. On the basis of a 100-year site curve, the mean site index is 67 for ponderosa pine and 80 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 52 cubic feet per acre for ponderosa pine at age 50 and 69 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre for ponderosa pine and 55 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on the Jumpe soil is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main concern for the harvesting of timber on the Jumpe soil is gaining access to the widely scattered, irregularly shaped timbered areas. The cobbles on the surface of the Bocker soil make access to the forested Jumpe soil difficult and thus hinder harvesting. Wheeled and tracked equipment can be used in skidding operations. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction generally is available on this unit.

Seedling establishment is the main concern in the production of timber on the Jumpe soil. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs infrequently. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants on the Jumpe soil are elk sedge, pinegrass, lupine, ceanothus, and bitterbrush. The crown density in the areas where the woodland site index was measured is 20 percent. This soil is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

The potential native rangeland vegetation on the Bocker soil is mainly Sandberg bluegrass, carrotleaf lomatium, and bottlebrush squirreltail. If the range is overgrazed, the proportion of preferred forage plants such as Sandberg bluegrass decreases and the proportion of less desirable forbs and annual grasses increases. The main limitations for the use of the Bocker soil as rangeland are cobbles on the surface, low available water capacity, and depth to rock. Livestock grazing during the hot summer months may concentrate on the tree-shaded Jumpe soil and on nearby areas of the Bocker soil.

This map unit is in capability subclass VIIs, nonirrigated.

8-Bocker-Sapkin complex, 0 to 25 percent slopes. This map unit is on smooth mountaintops and broad ridges. Slope is dominantly about 5 percent. The native vegetation is mainly grasses and shrubs. Elevation is 3,200 to 5,000 feet. The average annual precipitation is 18 to 35 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 95 to 130 days.

This unit is about 65 percent Bocker very cobbly loam, 0 to 25 percent slopes, and about 30 percent Sapkin very stony loam, 10 to 25 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Sapkin soils that have slopes of more than 15 percent, Jumpe and Sutkin soils, Rock outcrop, and soils that are similar to these Bocker and Sapkin soils but are 40 to 60 inches deep over bedrock. Included areas make up about 5 percent of the total acreage.

The Bocker soil is very shallow and well drained. It formed in residuum that is derived from basalt and includes a small amount of loess. Typically, the surface layer is dark grayish brown very cobbly loam about 3 inches thick. The subsoil is dark brown very cobbly loam about 4 inches thick. Fractured basalt is at a depth of about 7 inches. Depth to basalt ranges from 5 to 10 inches.

Permeability of the Bocker soil is moderate. Available water capacity is low. Effective rooting depth is 5 to 10 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Sapkin soil is moderately deep and well drained. It formed in residuum that is derived from basalt and includes a small amount of loess. Typically, the surface layer is about 15 inches thick. It is dark grayish brown very stony loam in the upper part and brown loam in the lower part. The upper part of the subsoil is brown cobbly loam about 12 inches thick, and the lower part is brown cobbly loam and extremely cobbly clay loam about 8 inches thick. Basalt is at a depth of about 35 inches. Depth to basalt ranges from 20 to 40 inches. In some areas the surface layer is 4 to 10 inches thick.

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

This unit is used for wildlife habitat and as rangeland.

The potential native vegetation on the Bocker soil is mainly Sandberg bluegrass, eriogonum, and bottlebrush squirreltail, and on the Sapkin soil it is mainly Idaho fescue, bluebunch wheatgrass, and threetip sagebrush. The production of forage is limited by the very cobbly surface layer, depth to rock, and low available water capacity. Areas that are heavily infested with undesirable vegetation can be improved with such practices as chemical treatment and prescribed burning.

This map unit is in capability subclass VIIs, nonirrigated.

9-Bocker-Sutkin complex, 0 to 7 percent slopes. This map unit is on smooth mountaintops and broad ridges. Slope is dominantly about 5 percent. The native vegetation is mainly grasses, shrubs, and scattered trees. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 95 to 130 days.

This unit is about 65 percent Bocker very cobbly loam and about 30 percent Sutkin stony loam. The components of this unit are so intricately intermingled

that it was not practical to map them separately at the scale used.

Included in the unit are small areas of Sutkin soils that have slopes of more than 15 percent or that have a very cobbly clay subsoil. Included areas make up about 5 percent of the total acreage.

The Bocker soil is very shallow and well drained. It formed in residuum that is derived from basalt and includes a small amount of loess. Typically, the surface layer is dark grayish brown very cobbly loam about 3 inches thick. The subsoil is dark brown very cobbly loam about 4 inches thick. Fractured basalt is at a depth of about 7 inches. Depth to basalt ranges from 5 to 10 inches.

Permeability of the Bocker soil is moderate. Available water capacity is low. Effective rooting depth is 5 to 10 inches. Runoff is medium, and the hazard of water erosion is Slight.

The Sutkin soil is very deep and well drained. Typically, the surface layer is covered with a mat of partially decomposed organic material about 1/2 inch thick. The surface layer is dark brown stony loam about 10 inches thick. The subsoil is dark yellowish brown very cobbly loam and extremely cobbly loam about 28 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

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

This unit is used for wildlife habitat and as rangeland and grazable woodland.

Ponderosa pine and Douglas-fir are the main woodland species on the Sutkin soil. On the basis of a 100-year site curve, the mean site index is 67 for ponderosa pine and 81 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 52 cubic feet per acre for ponderosa pine at age 50 and 71 cubic feet per acre for Douglas-fir at age 45. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre for ponderosa pine and 50 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on the Sutkin soil is about 90 percent that of normal stands, and the total yield is correspondingly lower.

The main concern for the harvesting of timber is gaining access to the widely scattered, irregularly shaped timbered areas of the Sutkin soil. The cobbles on the surface of the Bocker soil make access to the forested Sutkin soil difficult and thus hinder harvesting. Wheeled and tracked equipment can be used in skidding operations. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction generally is available on this unit.

Seedling establishment on the Sutkin soil is the main concern in the production of timber. Where seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs infrequently. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. Droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants on the Sutkin soil are mainly pinegrass, elk sedge, yarrow, bitterbrush, and common snowberry. The crown density in the areas where the woodland site index was measured is 25 percent. This soil is well suited to grazing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

The potential native vegetation on the Bocker soil is mainly Sandberg bluegrass, eriogonum, and lomatium. The production of forage is limited by the very cobbly surface layer, depth to rock, and low available water capacity.

If the range is overgrazed, the proportion of preferred forage plants such as Sandberg bluegrass decreases and the proportion of less desirable forbs and annual grasses increases. Livestock grazing during the hot summer months tends to concentrate on the shaded Sutkin soil and on nearby areas of the Bocker soil.

This map unit is in capability subclass VIIs, nonirrigated.

10-Burke silt loam, 2 to 5 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess over a lime- and silica-cemented hardpan. Slope is dominantly about 4 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan commonly is underlain by basalt. In some areas the surface layer is very fine sandy loam, in some areas fragments of the hardpan are scattered throughout the profile and on the surface, and in some areas the hardpan is underlain by gravelly alluvium, tuffaceous sandstone, or alternate layers of loess and hardpan.

Permeability of this Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the cemented pan and the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used generally depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content and tilth. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion.

Growing mint in meadows rather than in rows greatly reduces water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. Exposing the hardpan when leveling fields should be avoided. Shallow cuts are feasible in some areas.

This unit is poorly suited to homesite development. The main limitation is the depth to the cemented pan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the depth to the cemented pan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIIe, irrigated.

11-Burke silt loam, 5 to 8 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess over a lime- and silica-cemented hardpan. The average size of areas is less than 35 acres. Slope is dominantly about 7 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan commonly is underlain by basalt. In some areas the surface layer is very fine sandy loam, in some areas fragments of the hardpan are scattered throughout the profile and on the surface, and in some areas the hardpan is underlain by gravelly alluvium, tuffaceous sandstone, or alternate layers of loess and hardpan.

Included in this unit are small areas of Scoon, Shano, and Starbuck soils.

Permeability of this Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, wildlife habitat, and homesites. The main irrigated crops are corn, mint, grain, grapes, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the cemented pan, steepness of slope, and the hazard of water erosion. Drip and sprinkler irrigation systems are suited to the soil in this unit. The type of system used generally depends on the kind of crop grown. Use of drip or sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of minimum tillage-and return of crop residue to the soil improve the organic matter content and tilth. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows also greatly reduces water erosion.

This unit is poorly suited to homesite development. The main limitation is the depth to the cemented pan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the depth to the cemented pan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIIe, irrigated.

12-Burke silt loam, 8 to 15 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess over a lime- and silica-cemented hardpan. Slope is dominantly about 12 percent. The native vegetation is mainly forbs and shrubs. Elevation is 1,000 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan is commonly underlain by basalt. In some areas the surface layer is very fine sandy loam, in some areas fragments of the hardpan are scattered throughout the profile and on the surface, and in some areas the hardpan is underlain by gravelly alluvium, tuffaceous sandstone, or alternate layers of loess and hardpan.

Included in this unit are small areas of Scoon, Shano, and Starbuck soils and areas of Burke soils that have slopes of less than 8 percent or more than 15 percent.

Permeability of this Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, for nonirrigated crops, as rangeland, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, and tree fruit. A cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, or seed.

The main limitations for irrigated crops are depth to the cemented pan, steepness of slope, and the hazard of water erosion. Because of the steepness of slope, sprinkler and drip irrigation systems are best suited to the soil in this unit. If sprinkler irrigation is used, puddling reduces the water intake rate and impairs aeration. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of annual or perennial cover crops reduces erosion. A rotation of grain followed by alfalfa and grass commonly is used.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using diversions, and stripcropping. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and proportion of less preferred forage plants such as big sagebrush, Sandberg bluegrass, and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses or legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the depth to the cemented pan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the depth to the cemented pan, which restricts the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Steepness of slope and the cemented pan can cause lateral movement and surfacing of effluent in downslope areas.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

13-Carmack loam, 0 to 25 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from basaltic conglomerate and tuffaceous sandstone. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 2,200 to 3,500 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is about 43 degrees F, and the average growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer, where mixed to a depth of about 7 inches, is brown loam. The lower part is pale brown loam about 8 inches thick. The upper part of the subsoil is brown loam and pale brown silty clay loam about 28 inches thick, and the lower part to a depth of 60 inches or more is pale brown loam.

Included in this unit are small depressional areas that are poorly drained and areas of Carmack soils that have slopes of 25 to 50 percent. Included areas make up about 5 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. Among the trees of limited extent are western larch and scattered grand fir. On the basis of a 100-year site curve, the mean site index is 105 for Douglas-fir and 82 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 112 cubic feet per acre for Douglas-fir at age 40 and 72 cubic feet per acre for ponderosa pine at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 100 cubic feet per acre for Douglas-fir and 60 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is short periods of seasonal soil wetness. Wheeled and tracked equipment can be used in skidding operations. Use of wheeled and tracked equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Skid trails and firebreaks in the steeper areas of this unit are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. Droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, lupine, and American vetch. The crown density in the areas where the woodland site index was measured is 30 percent. This unit is well suited to grazing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass IVe, nonirrigated.

14-Carmack cobbly loam, 25 to 50 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from basaltic conglomerate and tuffaceous sandstone. The native vegetation is conifers, grasses, and shrubs. Elevation is 2,200 to 3,500 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is about 43 degrees F, and the average growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer, where mixed to a depth of about 7 inches, is brown cobbly loam. The lower part is pale brown loam about 8 inches thick. The upper part of the subsoil is brown loam and pale brown silty clay loam 28 inches thick, and the lower part to a depth of 60 inches or more is pale brown loam. In some places, along drainageways and on convex slopes, the subsoil is gravelly.

Included in this unit are areas of Rock outcrop and Rubble land and areas of Carmack soils that have slopes of less than 25 percent. Included areas make up about 5 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 87 for Douglas-fir and 77 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 80 cubic feet per acre for Douglas-fir at age 40 and 65 cubic feet per acre for ponderosa pine at age 45. The mean annual for trees 6.6 inches in diameter and larger at 80 years of age is 65 cubic feet per acre for Douglas-fir and 50 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 75 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. Cable yarding systems may be safer, and they disturb the soil less. Use of wheeled and tracked equipment when the soil is wet can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and

ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, bitterbrush, Oregon-grape, and pinegrass. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIe, nonirrigated.

15-Carmack cobbly loam, 50 to 75 percent slopes. This very deep, well drained soil is on north-facing mountainsides. It formed in residuum derived from basaltic conglomerate and tuffaceous sandstone. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 2,200 to 3,500 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is about 43 degrees F, and the average growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer, where mixed to a depth of about 7 inches, is brown cobbly loam. The lower part is pale brown loam about 8 inches thick. The upper part of the subsoil is brown loam and pale brown silty clay loam about 28 inches thick, and the lower part to a depth of 60 inches or more is pale brown loam. In some areas on knolls and along drainageways the subsoil is gravelly.

Included in this unit are areas of Rock outcrop and Rubble land and areas of Carmack soils that have slopes of 25 to 50 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. Among the trees of limited extent are grand fir and western larch. On the basis of a 100-year site curve, the mean site index is 93 for Douglas-fir and 81 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 90 cubic feet per acre for Douglas-fir at age 40 and 71 cubic feet per acre for ponderosa pine at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 55 cubic feet per acre for Douglas-fir and 40 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 95 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer, and they disturb the soil less. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. Use of wheeled and tracked equipment when the soil is moist, produces ruts, compacts the soil, and damages tree roots. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas of Douglas-fir and ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. The droughtiness of the soil in this unit increases seedling morality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, and spirea. The production of understory vegetation is limited by the density of the overstory canopy. The crown density in the areas where the woodland site index was measured is 30 percent.

This unit is poorly suited to grazing. Steepness of slope limits access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful. Because of the steepness of slope, broadcast seeding should be used.

This map unit is in capability subclass VIIe, nonirrigated.

16-Carmack cobbly loam, 25 to 50 percent north slopes. This very deep, well drained soil is on north-facing mountainsides. It formed in residuum derived from basaltic conglomerate and tuffaceous sandstone. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 2,200 to 3,500 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is about 43 degrees F, and the average growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer, where mixed to a depth of about 7 inches, is brown cobbly loam. The lower part is pale brown loam about 8 inches thick. The upper part of the subsoil is brown loam and pale brown silty clay loam about 28 inches thick, and the lower part to a

depth of 60 inches or more is pale brown loam. In some areas, on knolls and along drainageways, the subsoil is gravelly.

Included in this unit are small areas of Rock outcrop and Rubble land and areas of Carmack soils that have slopes of less than 25 percent or more than 50 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. Among the trees of limited extent are grand fir and western larch. On the basis of a 100-year site curve, the mean site index is 93 for Douglas-fir and 81 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at age 40 is 90 cubic feet per acre for Douglas-fir and 71 cubic feet per acre for ponderosa pine. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 75 cubic feet per acre for Douglas-fir and 55 cubic feet per acre for ponderosa pine. The basal area typically is about the same as that of normal stands.

The main limitation for the harvesting of timber is steepness of slope, making the use of wheeled and tracked equipment difficult. Cable yarding systems may be safer, and they disturb the soil less. Use of wheeled and tracked equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. The protective layer of duff should be disturbed as little as possible.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. The droughtiness of the soil in this unit increases the mortality of seedlings.

The common forest understory plants are elk sedge, pinegrass, spirea, lupine, western yarrow, and Oregongrape. The crown density in the areas where the woodland site index was measured is 40 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIe, nonirrigated.

17-Carmack-Rock outcrop complex, 40 to 70 percent slopes. This map unit is on mountainsides. Slope is dominantly about 50 percent. Areas face south. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 2,200 to 3,500 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is about 43 degrees F, and the average growing season, at 28 degrees F, is 145 to 170 days.

This unit is about 55 percent Carmack loam and about 35 percent Rock outcrop. The components of this unit are so intricately intermingled it was not practical to map them separately at the scale used.

Included in this unit are small areas of Carmack soils that have slopes of less than 40 percent and areas of shallow soils and Rubble land below the Rock outcrop. Included areas make up about 10 percent of the total acreage.

The Carmack soil is very deep and well drained. It formed in residuum derived dominantly from basaltic conglomerate and tuffaceous sandstone. Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer, where mixed to a depth of about 7 inches, is brown loam. The lower part is pale brown loam about 8 inches thick. The upper part of the subsoil is brown loam and silty clay loam about 28 inches thick, and the lower part to a depth of 60 inches or more is pale brown loam.

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

Rock outcrop is exposed areas of bedrock occurring as bands and escarpments that generally extend from east to west.

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and scattered Douglas-fir are the main woodland species on the Carmack soil. On the basis of a 100-year site curve, the mean site index is 77 for ponderosa pine and 87 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inches in diameter and larger is 65 cubic feet per acre for ponderosa pine at age 45 and 80 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 50 cubic feet per acre for ponderosa pine and 65 cubic feet per acre for Douglas-fir. However, the typical basal area of stands is about 75 percent that of normal stands, and the total yield is correspondingly lower.

The main limitations for the harvesting of timber are steepness of slope and the areas of Rock outcrop. The areas of Rock outcrop hinder harvesting and force yarding and skidding paths to converge, which results in increased potential for erosion and soil compaction. Unsurfaced roads are soft when wet, and they may be impassable during spring runoff or in rainy periods. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Logging roads require suitable surfacing for year-round use. Rock for road construction is available on this unit.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. The areas of Rock outcrop limit the even distribution of reforestation. The droughtiness of the soil in this unit increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, bluebunch wheatgrass, common snowberry, and bitterbrush. The crown density in the areas where the woodland site index was measured is 20 percent. The Carmack soil is poorly suited to grazing. Steepness of slope and the areas of Rock outcrop limit access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

18-Cleman very fine sandy loam, 0 to 2 percent slopes. This very deep, well drained soil is on flood plains and alluvial fans. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,600 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown very fine sandy loam about 10 inches thick. Below this to a depth of 60 inches or more is brown and yellowish brown, stratified fine sandy loam, sandy loam, very fine sandy loam, and silt loam. In some areas the surface layer is silt loam, fine sandy loam, or loam, in some areas very gravelly loamy sand is below a depth of about 30 inches, and in some areas the subsoil is sandy clay loam.

Included in this unit are areas of Outlook, Esquatzel, Warden, Ashue, and Naches soils.

Permeability of this Cleman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. This unit is subject to rare periods of flooding. The hazard of soil blowing is high.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, hops, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation, maintaining crop residue on the surface, and using minimum tillage reduce soil blowing. Mulching may be needed to stabilize small areas where soil blowing begins. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of water erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIe, irrigated.

19-Cleman very fine sandy loam, 2 to 5 percent slopes. This very deep, well drained soil is on flood plains. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,600 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown very fine sandy loam about 10 inches thick. Below this to a depth of 60 inches or more is brown and yellowish brown, stratified fine sandy loam, sandy loam, very fine sandy loam, and silt loam. In some areas the surface layer is silt loam, fine sandy loam, or loam; in some areas very gravelly loamy sand is below a depth of about 40 inches; and in some areas the subsoil is sandy clay loam.

Included in this unit are areas of Esquatzel, Warden, Outlook, Ashue, Willis, Moxee, and Ritzville soils. Also included are areas of Cleman soils that have slopes of less than 2 percent.

Permeability of this Cleman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water

erosion is moderate. This unit is subject to rare periods of flooding. The hazard of soil blowing is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, hops, peas, and tree fruits. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazards of soil blowing and water erosion. Using a cropping system that includes close-growing, high-residue crops in the rotation, maintaining crop residue on the surface, and using minimum tillage reduce erosion. Mulching may be needed to stabilize small areas where soil blowing begins. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

Furrow, corrugation, drip, or sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of water erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

The main limitations for nonirrigated crops are low annual precipitation, the hazard of soil blowing, and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Soil blowing can be reduced by stripcropping and orienting rows at right angles to the prevailing wind. Water erosion can be reduced by seeding early in fall, using stubble mulch tillage, and shaping and seeding waterways to perennial grasses. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, needleandthread, and big sagebrush. The production of forage is limited by the hazard of soil blowing. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, and chemical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of seepage. Water tanks, springs, wells, and pipeline systems can be used to provide water for livestock.

Range seeding is a suitable practice if the range vegetation is in poor condition. Seeding should be done in fall using a drill. Adapted legumes and grasses should be seeded on this unit.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. These sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclasses IIe, irrigated, and IIIe, nonirrigated.

20-Cleman very fine sandy loam, 5 to 8 percent slopes. This very deep, well drained soil is on alluvial fans. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,600 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown very fine sandy loam about 10 inches thick. Below this to a depth of 60 inches or more is brown and yellowish brown, stratified fine sandy loam, sandy loam, very fine sandy loam, and silt loam. In some areas gravelly loamy sand is below a depth of about 40 inches, and in some areas the subsoil is sandy clay loam.

Included in this unit are small areas of Ashue and Naches soils.

Permeability of this Cleman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is high. This unit is subject to rare periods of flooding.

This unit is used for irrigated field and orchard crops, as rangeland, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazards of soil blowing and water erosion. Using a cropping system that includes close-growing, high-residue crops in the rotation, maintaining crop residue on the surface, and using minimum tillage reduce erosion. Mulching may be needed to stabilize small areas where soil blowing begins.

Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from

overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, needleandthread, and big sagebrush. The production of forage is limited by the hazard of soil blowing. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation car' be improved by such methods as railing, chaining, beating, and chemical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of seepage. Water tanks, springs, wells, and pipeline systems can be used to provide water for livestock.

Range seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIe, irrigated and nonirrigated.

21-Cleman very fine sandy loam, 8 to 15 percent slopes. This very deep, well drained soil is on alluvial fans. It formed in alluvium. Native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,600 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown very fine sandy loam about 10 inches thick. Below this to a depth of 60 inches or more is brown and yellowish brown, stratified fine sandy loam, sandy loam, very fine sandy loam, and silt loam. In some areas gravelly loamy sand is below a depth of about 40 inches, and in some areas the subsoil is sandy clay loam.

Included in this unit are small areas of Ashue and Naches soils and areas of Cleman soils that have slopes of less than 8 percent.

Permeability of this Cleman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more, Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is high. This unit is subject to rare periods of flooding.

This unit is used for irrigated field and orchard crops, for nonirrigated crops, as rangeland, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, and tree fruit. Grasses and legumes are grown for hay, pasture, or seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope, the hazard of soil blowing, and the hazard of water erosion. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce erosion. A rotation of grain followed by alfalfa and grass commonly is used. Mulching may be needed to stabilize small areas where soil blowing begins.

Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted-to the available water capacity, the water intake rate, and the crop needs.

The main limitations for nonirrigated crops are low annual precipitation, the hazard of soil blowing, and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer falllow is most suitable. Soil blowing can be reduced by stripcropping, stubble mulch farming, and seeding early and at right angles to the prevailing wind. Seeding early in fall and tilling and chiseling stubble fields either on the contour when the soil is dry or across the slope reduce water erosion. Construction of level terraces and stripcropping, either singly or in combination, may be needed. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, needleandthread, and big sagebrush. The production of forage is limited by the hazard of soil blowing. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, and chemical treatment.

This unit is poorly suited to livestock watering ponds because of seepage. Other water storage systems or pipelines should be used to provide water for livestock.

Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Dikes and

channels that have outlets to bypass floodwater can be used to protect buildings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are the hazard of flooding and steepness of slope. Slope can cause lateral seepage of effluent so that it surfaces in downslope areas. Septic tank absorption lines should be installed on the contour. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVe, irrigated, and IIIe, nonirrigated.

22-Clint very stony loam, 15 to 45 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess and in residuum derived from basalt. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,300 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 49 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the upper part of the surface layer is reddish brown very stony loam about 6 inches thick, and the lower part is reddish brown gravelly loam about 4 inches thick. The subsoil is reddish brown very gravelly loam about 9 inches thick. The substratum is dark brown extremely gravelly loam about 9 inches thick. Basalt is at a depth of about 28 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are areas of McDaniel and Rock Creek soils and Rubble land. The percentage of included components varies from one area to another.

Permeability of this Clint soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The production of forage is limited by the low available water capacity and large stones. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of stoniness. The unit should be seeded in fall using a drill. Adapted legumes and grasses should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

23-Clint-Rubble land complex, 8 to 75 percent slopes. This map unit is on uplands. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,300 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 120 to 135 days.

This unit is 50 percent Clint very stony loam and 25 percent Rubble land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 10 percent McDaniel soils and about 15 percent Rock Creek soils. Also included are areas of Rock outcrop. Included areas make up about 25 percent of the total acreage.

The Clint soil is moderately deep and well drained. It formed in loess and in residuum derived from basalt. Typically, the upper part of the surface layer is reddish brown very stony loam about 6 inches thick, and the lower part is reddish brown gravelly loam about 4 inches thick. The subsoil is reddish brown very gravelly loam about 9 inches thick. The substratum is dark brown extremely gravelly loam about 9 inches thick. Basalt is at a depth of about 28 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Clint soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

Rubble land is areas of basalt cobbles, stones, and boulders. It does not support vegetation.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on the Clint soil is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The production of forage is limited by the steepness of slope, large stones on the surface, and the areas of Rubble land. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Brush control is largely limited to aerial applications of chemicals or prescribed burning because of the steepness of slope and the areas of Rubble land. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water tanks, and fences promotes more uniform distribution of grazing.

Range seeding on the Clint soil is a suitable practice if the range vegetation is in poor condition; however, seeding is difficult because of the large stones and the areas of Rubble land. The soil should be seeded in fall by broadcasting. Adapted legumes and grasses should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

24-Cowiche loam, 2 to 5 percent slopes. This very deep, well drained soil is on uplands. It formed in

residuum derived from sandstone and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 135 to 160 days.

Typically, the surface layer is grayish brown and brown loam about 10 inches thick. The subsoil is brown, yellowish brown, and pale brown loam about 25 inches thick. The upper part of the substratum is pale brown very fine sandy loam about 10 inches thick, and the lower part to a depth of 60 inches or more is brown loamy fine sand. In some areas weathered sandstone is at a depth of 40 to 60 inches.

Included in this unit are about 10 percent Willis soils, 5 percent Ritzville soils, and 5 percent Selah and Harwood soils.

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

This unit is used for irrigated field crops and orchards, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, hops, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Use of annual or perennial cover crops during the irrigation season reduces erosion in fields of hops and in orchards and vineyards (fig. 1). Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is suited to homesite development. The main limitation is the moderate shrink-swell potential. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the moderate permeability of the soil. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIe, irrigated.

25-Cowiche loam, 5 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from sandstone and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is 49 degrees F, and the average frost-free season is 135 to 160 days.

Typically, the surface layer is grayish brown and brown loam about 10 inches thick. The subsoil is brown, yellowish brown, and pale brown loam about 25 inches thick. The upper part of the substratum is pale brown very fine sandy loam about 10 inches thick, and the lower part to a depth of 60 inches or more is brown loamy fine sand. In some areas weathered sandstone is at a depth of 40 to 60 inches.

Included in this unit are about 10 percent Willis soils, 5 percent Ritzville soils, and 5 percent Selah and Harwood soils.

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

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve organic matter content, help to maintain soil structure, improve the water infiltration rate, and reduce erosion. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop

Figure 1.-Irrigated orchard with a permanent cover crop on Cowiche loam, 2 to 5 percent slopes.

residue on the surface also reduce erosion. A rotation of grain followed by alfalfa and grass commonly is used. Using cover crops in orchards and vineyards during the irrigation season reduces erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is suited to homesite development. The main limitation is the moderate shrink-swell potential. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling excavations with material that has low shrink-swell potential. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is moderate permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIe, irrigated.

26-Cowiche loam, 8 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from sandstone and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 135 to 160 days.

Typically, the surface layer is grayish brown and brown loam about 10 inches thick. The subsoil is brown, yellowish brown, and pale brown loam about 25 inches thick. The upper part of the substratum is pale brown very fine sandy loam about 10 inches thick, and the lower part to a depth of 60 inches or more is brown

loamy sand. In some areas weathered sandstone is at a depth of 40 to 60 inches.

Included in this unit are about 10 percent Willis soils, 5 percent Ritzville soils, 5 percent Selah and Harwood soils, and areas of Cowiche loam that has slopes of less than 8 percent.

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

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, and tree fruit. A cover crop is grown in orchards. Grass and legumes are grown for hay, pasture, or seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain soil structure, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. A rotation of grain followed by alfalfa and grass commonly is used. Use of annual or perennial cover crops in orchards and vineyards during the irrigation season reduces erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding early and using stubble mulch tillage. Use of terraces and stripcropping, either singly or in combination, may be needed. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and Idaho fescue. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, and chemical treatment. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted legumes and grasses should be seeded.

This unit is suited to homesite development. The main limitations are the moderate shrink-swell potential and steepness of slope. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling excavations with material that has low shrink-swell potential. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are the moderate permeability of the soil and steepness of slope. Use of sandy backfill for the trench and long absorption lines helps to compensate for the moderate permeability. Slope can promote lateral seepage and surfacing of effluent in downslope areas. Absorption lines should be installed on the contour. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclasses IVe, irrigated, and IIIe, nonirrigated.

27-Cowiche loam, 15 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from sandstone and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 135 to 160 days.

Typically, the surface layer is grayish brown and brown loam about 10 inches thick. The subsoil is brown, yellowish brown, and pale brown loam about 25 inches thick. The upper part of the substratum is pale brown very fine sandy loam about 10 inches thick, and the lower part to a depth of 60 inches or more is brown loamy fine sand. In some areas weathered sandstone is at a depth of 40 to 60 inches.

Included in this unit are about 5 percent Willis soils, 10 percent Ritzville soils, and 5 percent Selah and Harwood soils.

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

This unit is used for irrigated and nonirrigated field and orchard crops, for wildlife habitat, and as rangeland and homesites. The main irrigated crops are grain, grapes, and tree fruit. A cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, or seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation,

applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops are needed in orchards and vineyards to reduce erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion is reduced if fall grain is seeded early and stubble mulch tillage is used. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Divided-slope farming and stripcropping are effective in reducing erosion. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and Idaho fescue. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, and chemical treatment. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted legumes and grasses should be seeded.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. This unit should be seeded to reduce erosion and soil slippage.

The main limitation for septic tank absorption fields is steepness of slope, which can promote lateral seepage and surfacing of effluent in downslope areas. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

28-Cowiche-Rock Creek complex, 5 to 15 percent slopes. This map unit is on uplands. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,400 feet. The average annual precipitation is about 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the frost-free season is about 135 to 160 days.

This unit is about 50 percent Cowiche loam and about 30 percent Rock Creek very stony silt loam. The Cowiche soil is on mounds, and the Rock Creek soil is in areas between the mounds. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Simcoe, Clint, Harwood, and Gorst soils. Also included are areas of Cowiche soils where about 25 percent of the surface layer has been removed by erosion. Included areas make up about 20 percent of the total acreage.

The Cowiche soil is very deep and well drained. It formed in residuum derived from sandstone and has a mantle of loess. Typically, the surface layer is grayish brown and brown loam about 10 inches thick. The subsoil is brown, yellowish brown, and pale brown loam about 25 inches thick. The upper part of the substratum is pale brown very fine sandy loam about 10 inches thick, and the lower part to a depth of 60 inches or more is brown loamy fine sand. In some areas weathered sandstone is at a depth of 40 to 60 inches.

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

The Rock Creek soil is very shallow and well drained. It formed in loess and in residuum derived from basalt. Typically, the surface layer is grayish brown very stony silt loam about 2 inches thick. The subsoil is grayish brown and brown very cobbly clay about 8 inches thick. Basalt is at a depth of about 10 inches. Depth to basalt ranges from 8 to 15 inches.

Permeability of the Rock Creek soil is moderately slow. Available water capacity is low. Effective rooting depth is 8 to 15 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation of the Cowiche soil is mainly bluebunch wheatgrass and Idaho fescue. The potential native vegetation of the Rock Creek soil is mainly stiff sagebrush, Sandberg bluegrass, and eriogonum. The main limitations for the production of forage on the Rock Creek soil are depth to rock and low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases.

Areas of the Cowiche soil that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, and chemical treatment. Care should be taken during brush control to disturb the Rock Creek soil as little as possible.

Range seeding on the Rock Creek soil is not feasible because of low available water capacity and depth to rock. Proper range use and periodic rest are the most effective methods of range management and erosion control. Range seeding on the Cowiche soil is a suitable practice if the range vegetation is in poor condition. The soil should be seeded in fall using a drill. Adapted legumes and grasses should be seeded.

This map unit is in capability subclass VIs, non irrigated.

29-Cryumbrepts, gently sloping. These very deep, well drained soils are on terraces. They formed in old mixed alluvium and volcanic ash. Slope is 0 to 10 percent. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 4,700 to 5,200 feet. The average annual precipitation is 30 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, as 100 to 170 days.

No single profile of Cryumbrepts is typical, but one commonly observed in the survey area is covered with a mat of partially decomposed organic material about 1 1/2 inches thick. The surface layer is brown loam about 19 inches thick. The subsoil is brown loam about 8 inches thick. The upper part of the substratum is yellowish brown loam about 12 inches thick, and the lower part to a depth of 60 inches or more is yellowish brown sandy loam.

Included in this unit are 10 percent Aquic Cryandepts along streams and in depressional areas and about 5 percent Naxing soils in convex areas near the border of the unit.

Permeability of these Cryumbrepts is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight.

This unit is used as grazable woodland and for wildlife habitat.

Lodgepole pine, western larch, and grand fir are the main woodland species on this unit. Among the trees of limited extent are subalpine fir and Engelmann spruce. On the basis of a 100-year site curve, the mean site index is 89 for lodgepole pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for lodgepole pine is about 100 cubic feet per acre at 100 years of age. On the basis of a 50-year site curve, the mean site index is 50 for western larch. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination for western larch trees 0.6 inch in diameter and larger at 70 years of age is 63 cubic feet per acre. The mean annual increment for trees 7.6 inches in diameter and larger at 80 years of age is 50 cubic feet per acre. However, the typical basal area of stands on this unit is about 105 percent that of normal stands, and the total yield is correspondingly higher.

Snowpack hinders the use of equipment on this unit and limits access in winter. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages tree roots. Logging roads require suitable surfacing for year round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by lodgepole pine and western larch occurs readily.

The common forest understory plants are lupine, yarrow, and strawberry. The crown density in the areas where the woodland site index was measured is 35 percent. This unit is suited to grazing and browsing. It has few limitations for the production of forage. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIe, nonirrigated.

30-Darland stony loam, 45 to 75 percent slopes. This very deep, well drained soil is on south-facing mountainsides. It formed in colluvium derived from basalt. The native vegetation is mainly grasses, scattered trees, forbs, and shrubs. Elevation is 5,000 to 6,900 feet. The average annual precipitation is 25 to 45 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 100 to 120 days.

Typically, the upper part of the surface layer is dark yellowish brown stony loam about 8 inches thick, and the lower part is dark brown very gravelly loam and very cobbly loam about 23 inches thick. The subsoil is dark yellowish brown extremely cobbly loam about 12 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly sandy loam. In some areas the surface layer is severely eroded, in some areas there are no stones in the surface layer, and in some areas basalt is at a depth of 20 to 60 inches. At the southern edge of the headwaters of Foundation Creek, the parent material is shale.

Included in this unit are areas of Naxing soils on benches; areas of extremely stony soils; small concave areas of soils that have slopes of 20 to 45 percent; and soils, on ridgetops, that have slopes of 5 to 20 percent. Included areas make up about 10 percent of the total acreage.

Permeability of this Darland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is very rapid, and the hazard of water erosion is very high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on this unit is mainly Idaho fescue, Cusick bluegrass, elk sedge, and mountain brome. The main limitations for the production of forage are steepness of slope and stones on the surface. Steepness of slope promotes overgrazing of the less sloping areas. If the range is overgrazed, the proportion of preferred forage plants such as Cusick bluegrass decreases and the proportion of less preferred forage

plants such as cheatgrass and sagebrush increases. Brush control is largely limited to aerial application of chemicals or prescribed burning. Proper location of salt licks, stock water tanks, and fences improves the distribution of livestock grazing. Seeding is limited by stones on the surface and steepness of slope.

This unit is poorly suited to livestock watering ponds and other water impoundments. Water tanks, springs, wells, or pipeline systems can be used to provide water for livestock.

This map unit is in capability subclass VIIs, nonirrigated.

31-Darland-Rubble land complex, 45 to 75 percent slopes. This map unit is on mountainsides. Slope is dominantly about 60 percent. The native vegetation is mainly grasses, forbs, shrubs, and scattered trees. Elevation is 5,000 to 6,500 feet. The average annual precipitation is 25 to 45 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 100 to 120 days.

This unit is about 55 percent Darland stony loam and about 35 percent Rubble land. The Darland soil is in long, irregularly shaped areas, and Rubble land is talus fans on mountain toe slopes below areas of Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 5 percent Naxing soils and Aquic Cryandepts on benches and about 10 percent areas of Rock outcrop, severely eroded soils, and Darland soils that have slopes of 30 to 45 percent. The percentage varies from one area to another.

The Darland soil is very deep and well drained. It formed in colluvium derived from basalt. Typically, the upper part of the surface layer is dark yellowish brown stony loam about 8 inches thick. The lower part is dark brown very gravelly loam and very cobbly loam about 23 inches thick. The subsoil is dark yellowish brown extremely cobbly loam about 12 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly sandy loam. In some areas the surface layer does not have stones.

Permeability of the Darland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is very rapid, and the hazard of water erosion is very high.

Rubble land is areas of cobbles, stones, and boulders. It is mostly free of vegetation.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on the Darland soil is mainly Idaho fescue, Cusick bluegrass, elk sedge, and mountain brome. The main limitations for the production of forage are steepness of slope, large stones in the surface layer, and areas of Rubble land. Steepness of slope promotes overgrazing of the less sloping areas. If the range is overgrazed, the proportion of preferred forage plants such as Cusick bluegrass decreases and the proportion of less preferred forage plants such as sagebrush and cheatgrass increases. Brush control is limited mainly to aerial application of chemicals or prescribed burning. Proper location of salt licks, stock water tanks, and fences improves the distribution of livestock grazing. Seeding is limited by very steep slopes and the areas of Rock outcrop and Rubble land.

This unit is poorly suited to livestock watering ponds and other water impoundments. Water tanks, springs, wells, and pipeline systems can be used to provide water for livestock.

This map unit is in capability subclass VIIs, nonirrigated.

32-Esquatzel silt loam, 0 to 2 percent slopes. This very deep, well drained soil is on flood plains dissected by intermittent and perennial streams. It formed in silty alluvium. The native vegetation is grasses, forbs, and shrubs. Elevation is 650 to 1,500 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 160 days.

Typically, the surface layer is brown silt loam about 17 inches thick. The underlying material to a depth of 60 inches or more is pale brown silt loam. In some areas the surface layer is fine sandy loam, in some areas the soil is stratified with thin lenses of sandy loam, and in some areas very gravelly loamy sand is at a depth of 36 inches or more.

Included in this unit are small areas of Willis, Outlook, Warden, Umapine, and Selah soils.

Permeability of this Esquatzel soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very slow. This unit is subject to rare periods of flooding.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are asparagus, corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

This unit has few limitations for irrigated crops. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The rate of application of water should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and

leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve organic matter content, help to maintain tilth, and improve the infiltration rate. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This map unit is in capability class I, irrigated.

33-Esquatzel silt loam, 2 to 5 percent slopes. This very deep, well drained soil is on flood plains that are dissected by intermittent streams. It formed in silty alluvium. The native vegetation is grasses, forbs, and shrubs. Elevation is 650 to 1,500 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 160 days.

Typically, the surface layer is brown silt loam about 17 inches thick. The underlying material to a depth of 60 inches or more is pale brown silt loam. In some areas the surface layer is fine sandy loam, and in some areas the soil is stratified with thin lenses of fine sandy loam.

Included in this unit are small areas of Warden, Quincy, Willis, Scoon, Outlook, Finley, and Selah soils and areas of Esquatzel soils that have slopes of less than 2 percent.

Permeability of this Esquatzel soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. This unit is subject to rare periods of flooding.

This unit is used for irrigated and nonirrigated field and orchard crops, for wildlife habitat, and as rangeland and homesites. The main irrigated crops are asparagus, corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The rate of application of water should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion.

Growing mint in meadows rather than in rows greatly reduces water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are the low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable.

Erosion can be reduced by seeding fall grain early, stubble mulching, and shaping waterways and seeding them to perennial grass. Drop structures may be needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation on this unit is mainly basin wildrye, bluebunch wheatgrass, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, and chemical treatment. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Dikes-and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Dustiness can be a problem

during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This map unit is in capability subclasses IIe, irrigated, and IIIe, nonirrigated.

34-Fiander silt loam. This very deep, artificially drained soil is on flood plains. It formed in alluvium. Slope is 0 to 3 percent, but it is dominantly about 1 percent. The native vegetation is mainly alkali-tolerant grasses, forbs, and shrubs. Elevation is 700 to 900 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is moderately alkaline, grayish brown silt loam about 2 inches thick. The subsoil is strongly alkaline and very strongly alkaline, brown and pale brown silty clay loam about 23 inches thick. The upper part of the substratum is strongly alkaline, pale brown silt loam about 25 inches thick, and the lower part to a depth of 60 inches or more is mildly alkaline, brown loamy very fine sand.

Included in this unit are small areas of Umapine, Kittitas, and Toppenish soils and areas of undrained, salt-affected Fiander soils.

Permeability of this Fiander soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal water table that is at a depth of 24 to 36 inches from June to December. Runoff is very slow. This unit is subject to rare periods of flooding.

This unit is used for irrigated crops, as rangeland, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, and mint. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is slow permeability. If the drainage systems are not maintained, the soil in this unit has a seasonal high water table during the irrigation season and a high content of sodium. Tile drainage can be used to lower the water table if a suitable outlet is available. Dikes are effective in diverting floodwater and reducing the risk of flooding. Deep-rooted crops are suited to areas where the natural drainage is adequate or where a drainage system has been installed and maintained. Reclamation may require addition of amendments such as gypsum, sulfur, or ferric sulfate to facilitate leaching.

Furrow, corrugation, and sprinkler irrigation systems are suited to this soil. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to avoid compaction and to maintain or improve the organic matter content, improve the water infiltration rate, and help to maintain tilth. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The potential native vegetation on this unit is mainly basin wildrye, inland saltgrass. and black greasewood. The main limitations for the production of forage are wetness because of the seasonal high water table and high sodium content. If the range is overgrazed, the proportion of less preferred forage plants such as black greasewood and inland saltgrass increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, and chemical treatment. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted alkali-tolerant plants should be seeded.

The main limitations for homesite development are the hazard of flooding and soil wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in. Mulching, fertilizing, and irrigating are needed to establish lawn grasses and other small seeded plants.

The main limitations for septic tank absorption fields are the hazard of flooding, soil wetness, and slow permeability. Flooding can be controlled only by the use of major flood control structures. Slow permeability and the seasonal high water table increase the possibility of failure of septic tank absorption fields. Use of sandy backfill for the trench and long absorption lines helps to compensate for the slow permeability.

This map unit is in capability subclasses IVw, irrigated, and VIw, nonirrigated.

35-Finley fine sandy loam, 0 to 5 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air

temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the upper part of the surface layer is brown fine sandy loam about 4 inches thick, and the lower part is brown sandy loam about 10 inches thick. The subsoil is yellowish brown very gravelly loam about 16 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly sand. In some areas the surface layer is cobbly.

Included in this unit is areas of Quincy soils.

Permeability of this Finley soil is moderately rapid above the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass, needleandthread, Thurber needlegrass, and big sagebrush. The main limitations for the production of forage are low available water capacity and the hazard of soil blowing. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as annual forbs and big sagebrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, and chemical treatment. Seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIe, nonirrigated.

36-Finley cobbly fine sandy loam, 0 to 5 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the upper part of the surface layer is brown cobbly fine sandy loam about 4 inches thick. The lower part is brown sandy loam about 10 inches thick. The subsoil is yellowish brown very gravelly loam about 16 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly sand. In some areas the surface layer is not cobbly.

Included in this unit are areas of Quincy soils.

Permeability of this Finley soil is moderately rapid above the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass, needleandthread, Thurber needlegrass, and big sagebrush. The main limitations for the production of forage are low available water capacity and the hazard of soil blowing. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as annual forbs and big sagebrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Seedbed preparation is difficult because of large stones. This unit should be seeded in fall when moisture conditions are optimal. A drill should be used. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIe, nonirrigated.

37-Finley silt loam, 0 to 2 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 12 inches thick. The subsoil is yellowish brown very gravelly loam about 18 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly sand. In some areas the surface layer is sandy loam.

Included in this unit are small areas of Scooteney, Scoon, and Burke soils.

Permeability of this Finley soil is moderately rapid above the substratum and very rapid through it. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is moderate available water capacity. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely

critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve organic matter content, improve infiltration, and help to maintain tilth. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIIs, irrigated.

38-Finley silt loam, 2 to 5 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 12 inches thick. The subsoil is yellowish brown very gravelly loam about 18 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly sand.

Included in this unit are small areas of Burke, Scooteney, and Scoon soils and areas of Finley soils that have slopes of more than 5 percent.

Permeability of this Finley soil is moderately rapid above the substratum and very rapid through it. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are moderate available water capacity and the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of water erosion can be minimized by keeping runs short. Use of sprinkler and drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and reduce ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion.

Growing mint in meadows rather than in rows greatly reduces water erosion. Use of annual or perennial cover crops during the irrigation season reduces erosion in fields of hops, in orchards, and in vineyards. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIIe, irrigated.

39-Finley silt loam, 5 to 8 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 12 inches thick. The subsoil is yellowish brown very gravelly loam about 18 inches thick. The substratum to a depth

of 60 inches or more is yellowish brown extremely gravelly sand.

Included in this unit are small areas of Burke, Scooteney, and Scoon soils.

Permeability of this Finley soil is moderately rapid above the substratum and very rapid through it. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, grapes, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are moderate available water capacity, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing cover crops reduces erosion in orchards and vineyards.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIIe, irrigated.

40-Finley silt loam, 8 to 15 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 12 inches thick. The subsoil is yellowish brown very gravelly loam about 18 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly sand.

Included in this unit are small areas of Burke, Scooteney, and Scoon soils and areas of Finley soils that have slopes of 15 to 30 percent.

Permeability of this Finley soil is moderately rapid above the substratum and very rapid through it. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and grapes. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the moderate available water capacity, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Use of annual or perennial cover crops is needed in orchards and vineyards to reduce erosion. A rotation of grain followed by alfalfa and grass commonly is used.

This unit is suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. The unit should be seeded to reduce erosion and slippage of the soil. Cutbanks are not stable and subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage

from onsite sewage disposal systems. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Absorption lines should be installed on the contour. This map unit is in capability subclass IVe, irrigated.

41-Gorskel very stony loam, 0 to 25 percent slopes. This shallow, well drained soil is on terraces and foot slopes. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 3,000 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface layer is brown very stony loam about 5 inches thick. The upper part of the subsoil is yellowish brown gravelly loam about 3 inches thick, and the lower part is dark yellowish brown very gravelly clay loam about 5 inches thick. A hardpan is at a depth of about 13 inches. Depth to the hardpan ranges from 9 to 15 inches. In some areas the surface layer is stony silt loam.

Included in this unit are areas of Gorst, Harwood, Rock Creek, and Taneum soils.

Permeability of this Gorskel soil is moderately slow above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 9 to 15 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland, for wildlife habitat, and as homesites.

The potential native vegetation is mainly stiff sagebrush, Sandberg bluegrass, and eriogonum. The main limitations for the production of forage are large stones on the surface, low available water capacity, and low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases.

This unit is poorly suited to homesite development. The main limitations are the shallow depth to the hardpan and steepness of slope in areas where slopes are more than 15 percent. The pan hinders excavation. Access roads must be designed to control surface runoff and help stabilize cut slopes.

The main limitation for septic tank absorption fields is the depth to the cemented pan, which limits the capacity of the absorption field. Use of long absorption lines helps to compensate for this limitation. Absorption lines should be installed on the contour.

This map unit is in capability subclass VIIs, nonirrigated.

42-Gorskel-Harwood complex, 0 to 25 percent slopes. This map unit is on uplifted terraces. The native vegetation is mainly forbs and shrubs. Elevation is 1,200 to 2,300 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

This unit is about 50 percent Gorskel very stony loam and about 40 percent Harwood loam. The Harwood soil is on mounds, and the Gorskel soil is in areas between the mounds. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Gorst, Rock Creek, and Taneum soils. Included areas make up about 10 percent of the total acreage.

The Gorskel soil is shallow and well drained. It formed in loess and old alluvium. Typically, the surface layer is brown very stony silt loam about 5 inches thick. The upper part of the subsoil is yellowish brown gravelly loamabout 3 inches thick, and the lower part is dark yellowish brown very gravelly clay loam about 5 inches thick. A hardpan is at a depth of about 13 inches. Depth to the hardpan ranges from 9 to 15 inches.

Permeability of the Gorskel soil is moderately slow above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 9 to 15 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Harwood soil is moderately deep and well drained. It formed in loess and old alluvium. Typically, the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown loam about 18 inches thick. The substratum is brown gravelly loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation of the Gorskel soil is mainly stiff sagebrush, Sandberg bluegrass, and eriogonum. If the range plants on the Gorskel soil are overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases. The production of forage on the Gorskel soil is limited by depth to bedrock, large stones on the surface, and low available water capacity. The potential native vegetation of the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. If the range plants on the Harwood soil are overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas of the Harwood soil that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Care should be taken during brush control to disturb the Gorskel soil as little as possible. Range seeding on the Harwood soil is a suitable practice if the range is in poor condition. The soil should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

43-Gorst loam, 2 to 15 percent slopes. This well drained soil is on high, dissected terraces. It is shallow over a hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, and the average annual air temperature is about 50 degrees F; and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown loam about 7 inches thick. The subsoil is pale brown and brown loam about 8 inches thick. A hardpan is at a depth of about 15 inches. Depth to the hardpan ranges from 12 to 20 inches. In some areas the surface layer is cobbly, in some areas the subsoil is silty clay loam, and in some areas the soil is underlain by sandstone.

Included in this unit are about 5 percent Harwood soils and 5 percent Rock Creek soils.

Permeability of this Gorst soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 12 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops and as rangeland, wildlife habitat, and homesites. The main irrigated crop is tree fruit. Grasses and legumes are grown for hay, pasture, and seed. A perennial cover crop is grown in orchards.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these systems permits the even, controlled application of irrigation water, reduces runoff, and minimizes the risk of erosion. The depth to the hardpan and steepness of slope make water management extremely important. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Use of perennial cover crops in orchards reduces erosion.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Thurber needlegrass, and Sandberg bluegrass. The production of forage is limited by the low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is depth to the hardpan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclasses IVe, irrigated, and VIe, nonirrigated.

44-Gorst loam, 15 to 30 percent slopes. This well drained soil is on high, dissected terraces. It is shallow over a hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is brown loam about 7 inches thick. The subsoil is pale brown and brown loam about 8 inches thick. A hardpan is at a depth of about 15 inches. Depth to the hardpan ranges from 12 to 20 inches. In some areas the surface layer is cobbly, in some areas the subsoil is silty clay loam, and in some areas the soil is underlain by sandstone.

Included in this unit are about 5 percent Harwood soils and about 10 percent Rock Creek soils.

Permeability of this Gorst soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 12 to 20 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops and as rangeland, wildlife habitat, and homesites. The main irrigated crop is tree fruit. A perennial cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, or seed.

The main limitations for irrigated crops are the depth to the hardpan, steepness of slope, and the hazard of

water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Use of perennial cover crops is needed in orchards to reduce erosion.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Thurber needlegrass, and Sandberg bluegrass. The production of forage is limited by the low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as sagebrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are the depth to the hardpan and steepness of slope. The hardpan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan and steepness of slope. The pan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass VIe, irrigated and nonirrigated.

45-Gorst cobbly loam, 0 to 25 percent slopes. This shallow, well drained soil is on high, dissected terraces. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown cobbly loam about 7 inches thick. The subsoil is pale brown and brown loam about 8 inches thick. A hardpan is at a depth of about 15 inches. Depth to the hardpan ranges from 12 to 20 inches. In some areas the surface layer is gravelly, in some areas the subsoil is silty clay loam, and in some areas the soil is underlain by sandstone.

Included in this unit are areas of Gorskel, Harwood, Rock Creek, and Simcoe soils.

Permeability of this Gorst soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 12 to 20 inches. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, as rangeland, and for wildlife habitat. The main irrigated crops are permanent grasses and legumes and tree fruit. A perennial cover crop is grown in orchards.

The main limitations for irrigated crops are the depth to the hardpan and steepness of slope. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing perennial cover crops in orchards reduces erosion. Seedbed preparation is difficult, and removal of stones may be necessary.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Thurber needlegrass, and Sandberg bluegrass. The production of forage is limited by large stones on the surface and low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as bitterbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. Use of equipment is difficult because of the cobbles. Removal of cobbles may be needed before seeding with a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIe, irrigated and nonirrigated.

46-Harwood loam, 2 to 5 percent slopes. This well drained soil is on high, dissected terraces. It is moderately deep over a hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown loam about 18 inches thick. The substratum is brown gravelly loam about 4 inches thick. A hardpan is at a depth of about

30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the soil is underlain by sandstone.

Included in this unit are about 10 percent Selah soils, 10 percent Gorst soils, and 5 percent Ritzville soils.

Permeability of this Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, nonirrigated crops, and wildlife habitat. It is also used as rangeland and homesites. The main irrigated crops are grain, grapes, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan and the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. Exposing the substratum when leveling fields should be avoided. Shallow cuts are feasible in some areas.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, and shaping waterways and seeding them to perennial grass. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, big sagebrush, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, plowing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is depth to the hardpan. The pan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIIe, irrigated and nonirrigated.

47-Harwood loam, 5 to 8 percent slopes. This well drained soil is on high, dissected terraces. It is moderately deep over a hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown loam about 18 inches thick. The substratum is brown gravelly loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the soil is underlain by sandstone.

Included in this unit are about 10 percent Selah soils, 10 percent Gorst soils, and 5 percent Ritzville soils.

Permeability of this Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the depth to the hardpan, the hazard of water erosion, and steepness of slope. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of

plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

The main limitation for nonirrigated crops is low annual precipitation. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding early in fall, using stubble mulch tillage, and shaping waterways and seeding them to perennial grass. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, big sagebrush, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass 'decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, and chemical treatment. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the depth to the hardpan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass Ille, irrigated and nonirrigated.

48-Harwood loam, 8 to 15 percent slopes. This well drained soil is on high, dissected terraces. It is moderately deep over a hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown loam about 18 inches thick. The substratum is brown gravelly loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the soil is underlain by sandstone.

Included in this unit are about 10 percent Selah soils, 5 percent Gorst soils, and 5 percent Ritzville soils.

Permeability of this Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, and tree fruit. A cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, or seed.

The main limitations for irrigated crops are depth to the hardpan, the hazard of water erosion, and steepness of slope. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. A crop rotation of grain followed by alfalfa and grass commonly is used.

The main limitations for nonirrigated crops are the low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding early in fall and using stubble mulch tillage. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Using level or gradient terraces and stripcropping, either singly or in combination, also reduce erosion. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, big sagebrush, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, and chemical treatment. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the depth to the hardpan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Absorption lines should be

installed on the contour. Slope can promote lateral seepage and surfacing of the effluent in downslope areas.

This map unit is in capability subclasses IVe, irrigated, and IIIe, nonirrigated.

49-Harwood loam, 15 to 30 percent slopes. This well drained soil is on high, dissected terraces. It is moderately deep over a hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown loam about 18 inches thick. The substratum is brown gravelly loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the soil is underlain by sandstone.

Included in this unit are about 10 percent Selah soils, 5 percent Gorst soils, and 5 percent Ritzville soils.

Permeability of this Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated and nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grapes and tree fruit. A cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, or seed.

The main limitations for irrigated crops are depth to the hardpan, the hazard of water erosion, and steepness of slope. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops are needed in orchards and vineyards to reduce erosion.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding early in fall and using stubble mulch tillage. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is frozen. Divided-slope farming or stripcropping also reduces erosion. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, big sagebrush, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are the depth to the hardpan and steepness of slope. The pan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields are the depth to the hardpan and steepness of slope. The hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Slope can promote lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

50-Harwood-Burke-Wiehl silt loams, 2 to 5 percent slopes. This map unit is on uplands. The native vegetation is grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 30 percent Harwood silt loam, about 30 percent Burke silt loam, and about 20 percent Wiehl silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Selah, Gorst, and Scoon soils and areas of soils that have slopes of less than 2 percent. Also included are areas of soils that have hardpan fragments scattered throughout the profile and on the surface. Included areas make up about 20 percent of the total acreage.

The Harwood soil is well drained. It is moderately deep over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is brown silt loam about 18 inches thick. The substratum is brown gravelly silt loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate.

The Burke soil is well drained. It is moderately deep over a hardpan. It formed in loess. Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate.

The Wiehl soil is moderately deep and well drained. It formed in loess. Typically, the surface layer is grayish brown silt loam about 3 inches thick. The subsoil is brown and pale brown silt loam about 18 inches thick. The substratum is pale brown gravelly silt loam about 6 inches thick. Weakly cemented sandstone is at a depth of about 27 inches. Depth to sandstone or laminated sediment ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Wiehl soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used for irrigated and nonirrigated crops, rangeland, homesites, and wildlife habitat. The main irrigated crops are grain, grapes, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazard of water erosion, depth to the hardpan in the Harwood and Burke soils, and depth to soft sandstone in the Wiehl soil. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soils in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of water erosion can be minimized by keeping runs short. Sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content and to maintain tilth. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. Exposing the substratum when leveling fields should be avoided. Shallow cuts are feasible in some areas.

The main limitations for nonirrigated crops are the low annual precipitation, the moderate available water capacity, and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, and shaping waterways and seeding them to perennial grass. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation of the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation of the Burke soil is mainly bluebunch wheatgrass, Sandberg bluegrass and Thurber needlegrass. The potential native vegetation of the Wiehl soil is mainly bluebunch wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such practices as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are depth to the hardpan in the Harwood and Burke soils and depth to soft sandstone in the Wiehl soil. The hardpan and sandstone hinder excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan in the Harwood and Burke soils and depth to soft sandstone in the Wiehl soil. The hardpan and sandstone limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for these limitations.

This map unit is in capability subclasses IIIe, irrigated, and IVe, nonirrigated.

51-Harwood-Burke-Wiehl silt loams, 5 to 8 percent slopes. This map unit is on uplands. The native vegetation is grasses, forbs, and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 30 percent Harwood silt loam, about 30 percent Burke silt loam, and about 20 percent Wiehl silt loam. The components of this unit are so intricately

intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Gorst, Selah, and Scoon soils and areas of soils that have slopes of less than 5 percent. Also included are areas of soils that have hardpan fragments scattered throughout the profile and on the surface. Included areas make up about 20 percent of the total acreage.

The Harwood soil is well drained. It is moderately deep over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is brown silt loam about 18 inches thick. The substratum is brown gravelly silt loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Burke soil is well drained and it is moderately deep over a hardpan. It formed in loess. Typically, the surface layer is pale brown silt loam about 7 inches thick. The underlying material is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Wiehl soil is moderately deep and well drained. It formed in loess. Typically, the surface layer is grayish brown silt loam about 3 inches thick. The subsoil is brown and pale brown silt loam about 18 inches thick. The substratum is pale brown gravelly silt loam about 6 inches thick. Weakly cemented sandstone is at a depth of about 27 inches. Depth to sandstone or laminated sediment ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Wiehl soil is moderate above the sandstone and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope, the hazard of water erosion, depth to the hardpan in the Harwood and Burke soils, and depth to soft sandstone in the Wiehl soil. Sprinkler and drip irrigation systems are suited to the soils in this unit. The type of system used depends on the kind of crop grown. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion.

The potential native vegetation of the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation on the Burke soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The potential native vegetation of the Wiehl soil is mainly bluebunch wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are depth the hardpan in the Harwood and Burke soils and depth to soft sandstone in the Wiehl soil. The hardpan and soft sandstone hinder excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan in the Harwood and Burke soils and depth to soft sandstone in the Wiehl soil. The hardpan and sandstone limit the capacity of the absorption fields. Use of long absorption lines helps to compensate for these limitations.

This map unit is in capability subclass IIIe, irrigated.

52-Harwood-Burke-Wiehl silt loams, 8 to 15 percent slopes. This map unit is on uplands. The native vegetation is grasses, forbs, and shrubs. Elevation is 1,000 to 1,300 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 30 percent Harwood silt loam, about 30 percent Burke silt loam, and about 20 percent Wiehl silt loam. The components of this unit are so intricately

intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 10 percent Selah soils, 5 percent Ritzville soils, and 5 percent Scoon and Scooteney soils and areas of soils that have slopes of more than 15 percent. Also included are areas of soils that have hardpan fragments scattered throughout the profile and on the surface and areas of soils that have laminated sediment at a depth of 20 to 40 inches. These included areas make up about 25 percent of the total acreage.

The Harwood soil is well drained. It is moderately deep over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is brown silt loam about 18 inches thick. The substratum is brown gravelly silt loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Burke soil is well drained. It is moderately deep over a hardpan. It formed in loess. Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Wiehl soil is moderately deep and well drained. It formed in loess. Typically, the surface layer is grayish brown silt loam about 3 inches thick. The subsoil is brown and pale brown silt loam about 18 inches thick. The substratum is pale brown gravelly silt loam about 6 inches thick. Weakly cemented sandstone is at a depth of about 27 inches. Depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Wiehl soil is moderate above the soft sandstone and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, homesites, and wildlife habitat. The main irrigated crops are grain, grapes, and tree fruit. A cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope, the hazard of erosion, depth to the hardpan in the Harwood and Burke soils, and depth to soft sandstone in the Wiehl soil. Sprinkler and drip irrigation systems are suited to the soils in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. A rotation of grain followed by alfalfa and grass commonly is used. Growing annual or perennial cover crops in orchards and vineyards reduces water erosion.

The main limitations for nonirrigated crops are low annual precipitation, moderate available water capacity, and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early and stubble mulching. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Using terraces and stripcropping, either singly or in combination, also reduce erosion. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation on the Burke soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The potential native vegetation on the Wiehl soil is mainly bluebunch wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are depth to the hardpan in the Harwood and Burke soils, depth to soft sandstone in the Wiehl soil, and steepness of slope. The hardpan and soft sandstone hinder excavation. Dustiness can be a

problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan in the Harwood and Burke soils and depth to soft sandstone in the Wiehl soil. The hardpan and sandstone limit the capacity of the absorption fields. Use of long absorption lines helps to compensate for these limitations. Absorption lines should be installed on the contour. Slope can promote lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

53-Harwood-Burke-Wiehl silt loams, 15 to 30 percent slopes. This map unit is on uplands. The native vegetation is grasses, forbs, and shrubs. Elevation is 11,000 to 1,300 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 30 percent Harwood silt loam, about 30 percent Burke silt loam, and about 20 percent Wiehl silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Ritzville, Selah, Starbuck, and Scoon soils, salt- and alkali-affected soils, Rock outcrop, and soils that have slopes of less than 15 percent or more than 30 percent. Also included are areas of soils that have hardpan fragments scattered through the profile and areas of soils that have laminated sediment at a depth of 20 to 40 inches. These included areas make up about 20 percent of the total acreage.

The Harwood soil is well drained. It is moderately deep over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is brown silt loam about 18 inches thick. The substratum is brown gravelly silt loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

The Burke soil is well drained and is moderately deep over a hardpan. It formed in loess. Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

The Wiehl soil is moderately deep and well drained. It formed in loess. Typically, the surface layer is grayish brown silt loam about 3 inches thick. The subsoil is brown and pale brown silt loam about 18 inches thick. The substratum is pale brown gravelly silt loam about 6 inches thick. Weakly cemented, soft sandstone is at a depth of about 27 inches. Depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam.

Permeability of the Wiehl soil is moderate above the sandstone and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated hay, pasture, and orchard crops, for nonirrigated crops, as rangeland and homesites, and for wildlife habitat. The main irrigated crops are grasses, legumes, grapes, and tree fruit. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope, the hazard of water erosion, depth to the hardpan in the Harwood and Burke soils, and depth to sandstone in the Wiehl soil. Sprinkler and drip irrigation systems are suited to the soils in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops are needed in orchards and vineyards to reduce water erosion.

The main limitations for nonirrigated crops are low annual precipitation, the hazard of water erosion, and moderate available water capacity. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Seeding fall grain early and stubble mulching reduce the risk of erosion. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Divided-slope farming and stripcropping also reduce erosion. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation of the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation of the Burke soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The potential native vegetation of the Wiehl soil is mainly bluebunch

wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are steepness of slope and depth to the hardpan in the Harwood and Burke soils and depth to sandstone in the Wiehl soil. The hardpan and sandstone hinder excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are steepness of slope, depth to the hardpan in the Harwood and Burke soils, and depth to sandstone in the Wiehl soil. The hardpan and sandstone limit the capacity of the absorption fields. Use of long absorption lines helps to compensate for these limitations. Slope can promote lateral seepage and surfacing of effluent in downslope areas.

This map unit is capability subclass IVe, irrigated and nonirrigated.

54-Harwood-Burke-Wiehl silt loams, 30 to 60 percent slopes. This map unit is on uplands. The native vegetation is grasses, forbs, and shrubs. Elevation is 1,000 to 1,200 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 30 percent Harwood silt loam, 30 to 60 percent slopes; about 30 percent Burke silt loam, 30 to 40 percent slopes; and about 20 percent Wiehl silt loam, 30 to 60 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 10 percent Kiona soils, 5 percent Ritzville soils, and 5 percent Scoon soils and soils that have slopes of less than 30 percent. Also included are areas of soils that have hardpan fragments scattered throughout the profile and on the surface and areas of soils that have laminated sediment at a depth of 20 to 40 inches. These inclusions make up about 25 percent of the total acreage.

The Harwood soil is well drained. It is moderately deep over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is brown silt loam about 18 inches thick. The substratum is brown gravelly silt loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam or is very stony.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high.

The Burke soil is well drained and is moderately deep over a hardpan. It formed in loess. Typically, the surface layer is pale brown silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam or is very stony.

Permeability of the Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high.

The Wiehl soil is moderately deep and well drained. It formed in loess. Typically, the surface layer is grayish brown silt loam about 3 inches thick. The subsoil is brown and pale brown silt loam about 18 inches thick. The substratum is pale brown gravelly silt loam about 6 inches thick. Weakly cemented sandstone is at a depth of about 27 inches. Depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is very fine sandy loam or is very stony.

Permeability of the Wiehl soil is moderate above the sandstone and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation on the Burke soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The potential native vegetation on the Wiehl soil is mainly bluebunch wheatgrass and needleandthread. The production of forage is limited by the steepness of slope, which restricts access by livestock and promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water tanks, and fences promotes more uniform distribution of grazing.

If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Use of equipment is limited in

the more steeply sloping areas. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIe, nonirrigated.

55-Harwood-Burke-Wiehl very stony silt loams, 15 to 30 percent slopes. This map unit is on uplands. The native vegetation is grasses, forbs, and shrubs. Elevation is 1,000 to 1,300 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 30 percent Harwood very stony silt loam, about 30 percent Burke very stony silt loam, and about 20 percent Wiehl very stony silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit areas of Ritzville and Kiona soils and areas of soils that have slopes of less than 15 percent. Also included are areas of soils that have hardpan fragments scattered throughout the profile and soils that have laminated sediment at a depth of 20 to 40 inches. These included areas make up about 20 percent of the total acreage.

The Harwood soil is well drained and is moderately deep over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is grayish brown very stony silt loam about 8 inches thick. The subsoil is brown silt loam about 18 inches thick. The substratum is brown gravelly silt loam about 4 inches thick. A hardpan is at a depth of 30 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam and the soil does not have stones on the surface.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Burke soil is well drained and is moderately deep over a hardpan. It formed in loess. Typically, the surface layer is pale brown very stony silt loam about 7 inches thick. The substratum is pale brown silt loam about 18 inches thick. A hardpan is at a depth of about 25 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam and the soil does not have stones on the surface.

Permeability of the Burke soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Wiehl soil is moderately deep and well drained. It formed in loess. Typically, the surface layer is grayish brown very stony silt loam about 3 inches thick. The subsoil is brown and pale brown silt loam about 18 inches thick. The substratum is pale brown gravelly silt loam about 6 inches thick. Weakly cemented sandstone is at a depth of about 27 inches. Depth to sandstone ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam and the soil does not have stones on the surface.

Permeability of the Wiehl soil is moderate above the sandstone and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation on the Burke soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The potential native vegetation on the Wiehl soil is mainly bluebunch wheatgrass and needleandthread. The production of forage is limited by the large stones on the surface. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of the large stones on the surface. The unit should be seeded in fall using a drill or by broadcasting. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIs, nonirrigated.

56-Harwood-Gorst complex, 0 to 25 percent slopes. This map unit is on dissected terraces. The native vegetation is grasses, forbs, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

This unit is about 60 percent Harwood loam and about 30 percent Gorst cobbly loam. The Harwood soil is on mounds, and the Gorst soil is in areas between the mounds. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Cowiche, Selah, and Rock Creek soils. Also included are areas of Gorst soils that have a very cobbly or very gravelly surface layer and areas of Harwood and Gorst soils that have slopes of more than 25 percent. These included areas make up about 10 percent of the total acreage.

The Harwood soil is well drained. It is moderately deep over a hardpan. It formed in loess and old alluvium. Typically the surface layer is grayish brown loam about 8

inches thick. The subsoil is brown loam about 18 inches thick. The substratum is brown gravelly loam about 4 inches thick. A hardpan is at a depth of about 30 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Harwood soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Gorst soil is well drained. It is shallow over a hardpan. It formed in loess and old alluvium. Typically, the surface layer is brown cobbly loam about 7 inches thick. The subsoil is pale brown and brown loam about 8 inches thick. A hardpan is at a depth of about 15 inches. Depth to the hardpan ranges from 12 to 20 inches.

Permeability of the Gorst soil is moderate above the hardpan and very slow through it. Available water capacity is low, Effective rooting depth is 12 to 20 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as rangeland and for irrigated field and orchard crops, wildlife habitat, and homesites. The main irrigated crops are tree fruit and grasses and legumes grown for hay, pasture, and seed. A perennial cover crop is grown in orchards.

The potential native vegetation on the Harwood soil is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The potential native vegetation on the Gorst soil is mainly bluebunch wheatgrass and Thurber needlegrass. The production of forage is limited by the low annual precipitation, depth to the hardpan, very low available water capacity, and large stones on the Gorst soil. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Undesirable vegetation on the Gorst soil can be controlled by chemical methods. Use of equipment is difficult because of the presence of cobbles. Removal of the cobbles may be necessary before using equipment. Adapted grasses and legumes should be seeded.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, the hazard of water erosion, and large stones on the surface of the Gorst soil. This unit can be leveled by spreading the mounds of the Harwood soil over the Gorst soil so that the entire area is underlain by a hardpan at a depth of about 16 to 25 inches. Exposing the hardpan when leveling fields should be avoided.

Shallow soil depth makes water management extremely important. Sprinkler and drip irrigation systems are suited to the soils in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Growing perennial cover crops in orchards reduces erosion.

This unit is poorly suited to homesite development. The main limitations are depth to the hardpan and steepness of slope in areas where the slope is more than 15 percent. The hardpan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is depth to the hardpan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Absorption lines should be installed on the contour. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass Vle, irrigated and nonirrigated.

57-Hezel loamy fine sand, 0 to 2 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in lacustrine sediment overlain by a mantle of eolian sand. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 800 feet. The average annual precipitation is 6 to 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free season is 150 to 180 days.

Typically, the surface layer is grayish brown loamy fine sand about 6 inches thick. The upper part of the underlying material is grayish brown and light brownish gray loamy fine sand about 16 inches thick, and the lower part to a depth of 60 inches or more is stratified, light brownish gray very fine sandy loam and silt loam.

Included in this unit are areas of Warden and Quincy soils. Also included, in depressional areas, are soils that have a high water table and a high salt content if the surrounding areas are irrigated.

Permeability of this Hezel soil is rapid in the loamy fine sand part and moderately slow in the underlying stratified material. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is high.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, potatoes, and corn. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of soil blowing. The type of irrigation system used depends on the kind of crop grown. A sprinkler system is best suited to the soil in this unit. Use of sprinkler irrigation permits the even, controlled application of irrigation

water, reduces runoff, and minimizes the risk of water erosion. Because of rapid permeability, irrigation furrows need to be compacted and shaped so that irrigation water can reach the entire length of the run. This reduces the water intake rate. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Because this soil is droughty, frequent, light applications of irrigation water are needed.

The hazard of sail blowing makes tillage and residue management extremely important. This unit should be protected with cover crops or crop residue through the period of soil blowing in spring until the crop is well established. Sufficient crop residue should be left on the surface. Fall grain, hay, or pasture should be seeded late in August or early in September to provide sufficient cover.

Use of straw, manure, or other waste material as a mulch reduces soil blowing, helps to maintain or improve the organic matter content, and conserves moisture. Seedbeds should be prepared when irrigation water is available to keep the soil surface moist. Vegetative barriers and shelterbelts are suitable for controlling soil blowing. Small grain can be used as a nurse crop when establishing grasses and legumes.

This unit has few limitations for homesite development. Building sites should be disturbed as little as possible. The main limitation for septic tank absorption fields is the moderately slow permeability, which affects the rate of absorption of the effluent. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IVe, irrigated.

58-Hezel loamy fine sand, 2 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in lacustrine sediment overlain by a mantle of eolian sand. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 800 feet. The average annual precipitation is 6 to 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free season is about 150 to 180 days.

Typically, the surface layer is grayish brown loamy fine sand about 6 inches thick. The upper part of the underlying material is grayish brown and light brownish gray loamy fine sand about 16 inches thick, and the lower part to a depth of 60 inches or more is stratified, light brownish gray loamy very fine sandy loam and silt loam.

Included in this unit are areas of Warden and Quincy soils and soils, in depressional areas, that have a high water table and a high concentration of salt if the surrounding areas are irrigated. Also included are areas of Hezel soils that have slopes of more than 15 percent.

Permeability of this Hezel soil is rapid in the loamy fine sand part and moderately slow in the underlying stratified material. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high.

This unit is used for irrigated crops and as rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and potatoes. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazard of wind erosion. Sprinkler irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity the water intake rate, and the crop needs. Because of the droughtiness of the surface layer, frequent light applications of irrigation water are needed.

The high hazard of wind erosion makes proper tillage and residue management extremely important. This unit should be protected with a cover crop when it is susceptible to wind erosion in winter and with crop residue until crops are well established in spring. Crop rows should be at right angles to the prevailing wind wherever feasible. Fall grain, hay, or pasture should be seeded late in August or early in September to provide sufficient winter cover. Use of straw, manure, or other waste material as a mulch reduces soil blowing, helps to maintain or improve the organic matter content, and conserves moisture. Seedbeds should be prepared when irrigation water is available to keep the soil surface moist. Vegetative barriers and shelterbelts also reduce soil blowing.

The potential native vegetation on this unit is mainly needleandthread, Sandberg bluegrass, bluebunch wheatgrass, and big sagebrush. The production of forage is limited by the hazard of soil blowing. If the range is overgrazed, the proportion of preferred forage plants such as needleandthread and bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as balsamroot and big sagebrush increases.

Brush control is mainly limited to chemical application because of the high hazard of soil blowing. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded with a rangeland drill in fall when the moisture content of the soil is optimal. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Building sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is moderately slow permeability, which affects the rate of absorption of the effluent. Use of sandy backfill for the

trench and long absorption lines helps to compensate for this limitation. Absorption lines should be installed on the contour.

This map unit is in capability subclasses IVe, irrigated, and VIe, nonirrigated.

59-Jumpe stony loam, 5 to 25 percent slopes. This very deep, well drained soil is on long, broad mountain ridges. It formed in residuum and colluvium derived from basalt and a small amount of loess and volcanic ash. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,800 to 5,600 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material, about 2 inches thick. The surface layer is brown stony loam about 3 inches thick. The subsoil is brown and dark yellowish brown extremely cobbly loam about 38 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam. In some areas at an elevation of more than 5,000 feet, a layer of volcanic ash 4 to 12 inches thick is on the surface; in some areas the subsoil is clay loam or sandy loam; and in some areas basalt is at a depth of 30 to 40 inches.

Included in this unit are areas of Bocker soils and areas of Jumpe soils that have slopes of 25 to 45 percent.

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

The unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. Among the trees of limited extent are grand fir, western larch, and occasional dense stands of lodgepole pine. On the basis of a 100-year site curve, the mean site index is 80 for Douglas-fir, 67 for ponderosa pine, and 73 for grand fir. On the basis of a 50-year site curve, the mean site index is 59 for western larch. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 69 cubic feet per acre for Douglas-fir at age 40 and 52 cubic feet per acre for ponderosa pine at age 50. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 55 cubic feet per acre for Douglas-fir and 40 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, pinemat manzanita, and ceanothus. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIs, nonirrigated.

60-Jumpe stony loam, 25 to 45 percent slopes. This very deep, well drained soil is on mountainsides. It formed in residuum and colluvium derived from basalt and a small amount of loess and volcanic ash. Areas generally are on south-facing side slopes. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,600 to 5,800 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The surface layer is brown stony loam about 3 inches thick. The subsoil is brown and dark yellowish brown extremely cobbly loam about 38 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam. In some areas at an elevation of more than 5,000 feet, the soil has a mantle of volcanic ash 4 to 12 inches thick. In some areas the subsoil is clay loam or sandy loam.

Included in this unit are about 10 percent Sapkin soils, 5 percent Bocker soils, areas of Rock outcrop and Rubble land, areas of Jumpe soils that have slopes of 45 to 70 percent, and small concave areas of soils that have slopes of 5 to 25 percent.

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

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. Among the trees of limited extent

are grand fir, scattered western larch, and lodgepole pine. On the basis of a 100-year site curve, the mean site index is 86 for Douglas-fir, 64 for ponderosa pine, and 73 for grand fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 79 cubic feet per acre for Douglas-fir at age 40 and 50 cubic feet per acre for ponderosa pine at age 55. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 65 cubic feet per acre for Douglas-fir and 40 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. A cable warding system may be safer, and it disturbs the soil less. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, and ceanothus. The crown density in the areas where the woodland site index was measured is 25 percent This unit is well suited to grazing and browsing. It has few limitations for the production of forage. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

61-Jumpe stony loam, 45 to 65 percent slopes. This very deep, well drained soil is on mountainsides and in canyons. It formed in residuum and colluvium derived from basalt and small amounts of loess and volcanic ash. Areas generally are on south-facing side slopes. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,600 to 5,800 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The surface layer is brown stony loam about 3 inches thick. The subsoil is brown and dark yellowish brown extremely cobbly loam about 38 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam. In some areas at an elevation of more than 5,000 feet, the soil has a mantle of volcanic ash 4 to 12 inches thick. In some areas the subsoil is clay loam or sandy loam.

Included in this unit are about 10 percent Sapkin soils and about 15 percent areas of Rubble land, Rock outcrop, and Jumpe soils that have slopes of less than 45 percent.

Permeability of this Jumpe soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as grazable woodland and for wildlife

Douglas-fir and ponderosa pine are the main woodland species on this unit. Among the trees of limited extent are grand fir and western larch. On the basis of a 100-year curve, the mean site index is 86 for Douglas-fir, 64 for ponderosa pine, and 73 for grand fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 79 cubic feet per acre for Douglas-fir at age 40 and 50 cubic feet per acre for ponderosa pine at age 55. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 65 cubic feet per acre for Douglas-fir and 50 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 55 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and disturb the soil less. Areas of Rock outcrop and Rubble land hinder harvesting. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of Rubble land and Rock outcrop. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and ponderosa pine occurs periodically. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, and ceanothus. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is suited to browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful. Because of the steepness of slope, broadcast seeding should be used.

This map unit is in capability subclass VIIs, non irrigated.

62-Jumpe stony loam, 25 to 45 percent north slopes. This very deep, well drained soil is on mountainsides. It formed in residuum and colluvium derived from basalt and a small amount of loess and volcanic ash. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,200 to 5,600 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 135 to 160 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick and a layer of volcanic ash about 1/2 inch thick. The surface layer, where mixed to a depth of about 6 inches, is brown stony loam. The subsoil is dark brown and dark yellowish brown very cobbly loam about 31 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very cobbly loam. In some areas the soil has a mantle of volcanic ash about 12 inches thick.

Included in this unit are areas of Rock outcrop and Rubble land and areas of Jumpe soils that have slopes of less than 25 percent or more than 45 percent.

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

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir, grand fir, and western larch are the main woodland species on this unit. Among the trees of limited extent are lodgepole pine, Engelmann spruce, western white pine, and some ponderosa pine on the more nearly west- and east-facing side slopes. On the basis of a 100-year site curve, the mean site index is 75 for Douglas-fir, 73 for grand fir, and 65 for ponderosa pine. On the basis of a 50-year site curve, the mean site index is 42 for western larch. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for Douglas-fir trees 0.6 inch in diameter and larger at 45 years of age is 62 cubic feet per acre. The mean annual increment for Douglas-fir trees 6.6 inches in diameter and larger at 80 years of age is 55 cubic feet per acre. However, the typical basal area of stands on this unit is about 90 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. A cable yarding system may be safer, and it disturbs the soil less. The north-facing slopes of this unit retain snowpack, which delays access in spring. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction generally is available in the included areas of Rubble land and Rock outcrop.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by grand fir occurs readily and can delay establishment of planted seedlings. The droughtiness of the surface layer during the dry summer months increases seedling mortality.

The common forest understory plants are elk sedge, pinegrass, spirea, and lupine. The crown density in the areas where the woodland site index was measured is 35 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, non irrigated.

63-Jumpe stony loam, 45 to 65 percent north slopes. This very deep, well drained soil is on mountainsides and in canyons. It formed in residuum and colluvium derived from basalt and small amounts of loess and volcanic ash. The native vegetation is mainly conifers, grasses, and forbs. Elevation is 3,200 to 5,600 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 135 to 160 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick and a layer of volcanic ash about 1 /2 inch thick. The surface layer, where mixed to a depth of about 6 inches, is brown stony loam. The subsoil is dark brown and dark yellowish brown very cobbly loam about 31 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very cobbly loam. In some areas the soil has a mantle of volcanic ash about 12 inches thick.

Included in this unit are areas of Rubble land and Rock outcrop and small concave areas of Jumpe soils that have slopes of less than 45 percent.

Permeability of this Jumpe soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and grand fir are the main woodland species on this unit. Among the trees of limited extent are Engelmann spruce, subalpine fir, and dense pockets of western larch and lodgepole pine. On the basis of a 100-year site curve, the mean site index is 75 for Douglas-fir, 73 for grand fir, and 68 for lodgepole pine. Yield tables for normal, even-aged, unmanaged stands of Douglas-fir indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 45 years of age is 62 cubic feet per acre. The mean annual increment for Douglas-fir trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre. However, the typical basal area of stands on this unit is about 120 percent that of normal stands, and the total yield is correspondingly higher.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and disturb the soil less. The north-facing areas of this unit retain snowpack, which delays access in spring. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Rock for road construction generally is available in included areas of Rubble land and Rock outcrop. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by grand fir and subalpine fir occurs readily and can delay establishment of planted seedlings. The droughtiness of the surface layer during the dry summer months increases seedling mortality.

The common forest understory plants are lupine, pinegrass, and elk sedge. The crown density in the areas where the woodland site index was measured is 35 percent. This unit is poorly suited to grazing. Steepness of slope limits access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful. Because of the steepness of slope, broadcast seeding should be used.

This map unit is in capability subclass VIIs, nonirrigated.

64-Jumpe-Rock outcrop complex, 40 to 80 percent slopes. This map unit is on mountainsides and in canyons. Areas generally are on north-facing side slopes. The native vegetation is mainly conifers, grasses, and forbs. Elevation is 2,800 to 4,400 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 135 to 160 days.

This unit is about 60 percent Jumpe stony loam, 40 to 65 percent slopes, and about 20 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Rubble land and areas of soils that are underlain by bedrock at a depth of 20 to 40 inches. Also included are small concave areas of Jumpe soils that have slopes of less than 40 percent. These included areas make up about 20 percent of the total acreage.

The Jumpe soil is very deep and well drained. It formed in residuum and colluvium derived from basalt and small amounts of loess and volcanic ash. Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick and a layer of volcanic ash about 1/2 inch thick. The surface layer, where mixed to a depth of about 6 inches, is brown stony loam. The subsoil is dark brown and dark yellowish brown very cobbly loam about 31 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very cobbly loam.

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

Rock outcrop is areas of exposed bedrock.

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and grand fir are the main woodland species on the Jumpe soil. Among the trees of limited extent are Engelmann spruce, subalpine fir, and dense pockets of western larch and lodgepole pine. On the basis of a 100-year site curve, the mean site index is 75 for Douglas- fir, 73 for grand fir, and 68 for lodgepole pine. Yield tables for normal, even-aged, unmanaged stands of Douglas-fir indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 45 years of age is 62 cubic feet per acre. The mean annual increment for Douglas-fir trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre. However, the typical basal area of stands on the Jumpe soil is about 120 percent that of normal stands, and the total yields are correspondingly higher.

The main limitations for the harvesting of timber are the areas of Rock outcrop and Rubble land and steepness of slope. When harvesting timber, steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soil less. The areas of Rock outcrop and Rubble land may cause breakage of timber during felling, and they hinder yarding. The north-facing areas of this unit retain snowpack, which may delay access in spring. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads

require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by grand fir and subalpine fir occurs readily and can delay establishment of planted seedlings. The areas of Rock outcrop limit the even distribution of reforestation. The droughtiness of the surface layer during the dry summer months increases seedling mortality.

The common forest understory plants are elk sedge, pinegrass, and lupine. The crown density in the areas where the woodland site index was measured is 30 percent. The Jumpe soil is poorly suited to grazing. Steepness of slope and the areas of Rock outcrop limit access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

65-Kiona stony silt loam, 15 to 45 percent slopes. This very deep, well drained soil is on uplands. It formed in loess and colluvium derived from basalt. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 2,500 feet. The average annual precipitation is 7 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface layer is brown stony silt loam about 5 inches thick. The subsoil is pale brown very cobbly silt loam about 9 inches thick. The substratum to a depth of 60 inches or more is pale brown very cobbly silt loam.

Included in this unit are areas of Lickskillet, Starbuck, Ritzville, Burke, Shano, Renslow, and Bakeoven soils. Also included are areas of soils that are underlain by basalt at a depth of 30 to 40 inches, areas of Rock outcrop and Rubble land, and areas of Kiona soils that have slopes of less than 15 percent.

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

This unit is used as rangeland and for wildlife habitat. The potential native vegetation on this unit is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The production of forage is limited by large stones. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rubber rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chemical treatment and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. Mechanical seeding is difficult because of stoniness. This unit should be seeded with a drill in fall when the moisture content of the soil is optimal. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIs, nonirrigated.

66-Kittitas silt loam. This very deep, artificially drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 2 percent. The native vegetation is mainly salt-tolerant grasses and shrubs. Elevation is 700 to 1,100 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is dark grayish brown and grayish brown, very strongly alkaline silt loam about 19 inches thick. The upper part of the underlying material is light brownish gray, moderately alkaline silt loam about 22 inches thick, and the lower part to a depth of 60 inches or more is light brownish gray, moderately alkaline very fine sandy loam and fine sandy loam. In some areas the surface layer is silty clay loam.

Included in this unit are small areas of Toppenish and Umapine soils, areas of Kittitas soils that are not artificially drained and are salt-affected, and areas of Kittitas soils that have slopes of more than 2 percent.

Permeability of this Kittitas soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 42 inches from June to November. Runoff is very slow, and the hazard of water erosion is slight. This soil is subject to rare periods of flooding.

This unit is used for crops, for wildlife habitat, and as homesites. Where the unit is protected from flooding and is drained, leached, and irrigated, the main crops are corn, grain, and hops. Grasses and legumes are grown for hay, pasture, and seed. Deep-rooted crops are suited to areas where the drainage is adequate or where a drainage system has been installed and maintained.

If a drainage system is not maintained, the soil in this unit has a seasonal high water table during the irrigation season and has a high content of salt. Dikes can be used to divert floodwater and thus reduce the risk of flooding. Reclamation may require the addition of such amendments as gypsum, sulfur, or ferric sulfate to facilitate leaching.

Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The water application rate should be reduced to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation,

applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to avoid compaction, to maintain or improve the organic matter content, to maintain tilth, and to improve the water infiltration rate. Using vegetated filter strips at the end of rows and using sediment ponds, or both, reduces the amount of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Selection of adapted vegetation is critical for the establishment of lawns, shrubs, trees, and vegetable gardens.

The main limitations for septic tank absorption fields are the high water table and moderately slow permeability. The moderately slow permeability and the high water table increase the possibility of failure of septic tank absorption fields.

This map unit is in capability subclass IIIw, irrigated.

67-Lickskillet silt loam, 5 to 30 percent slopes. This shallow, well drained soil is on uplands. It formed in loess and in residuum and colluvium derived from basalt. Most slopes are about 10 percent. The native vegetation is mainly grasses, forbs, and shrubs (fig. 2). Elevation is 1,500 to 3,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface layer is grayish brown silt loam about 3 inches thick. The upper part of the subsoil is

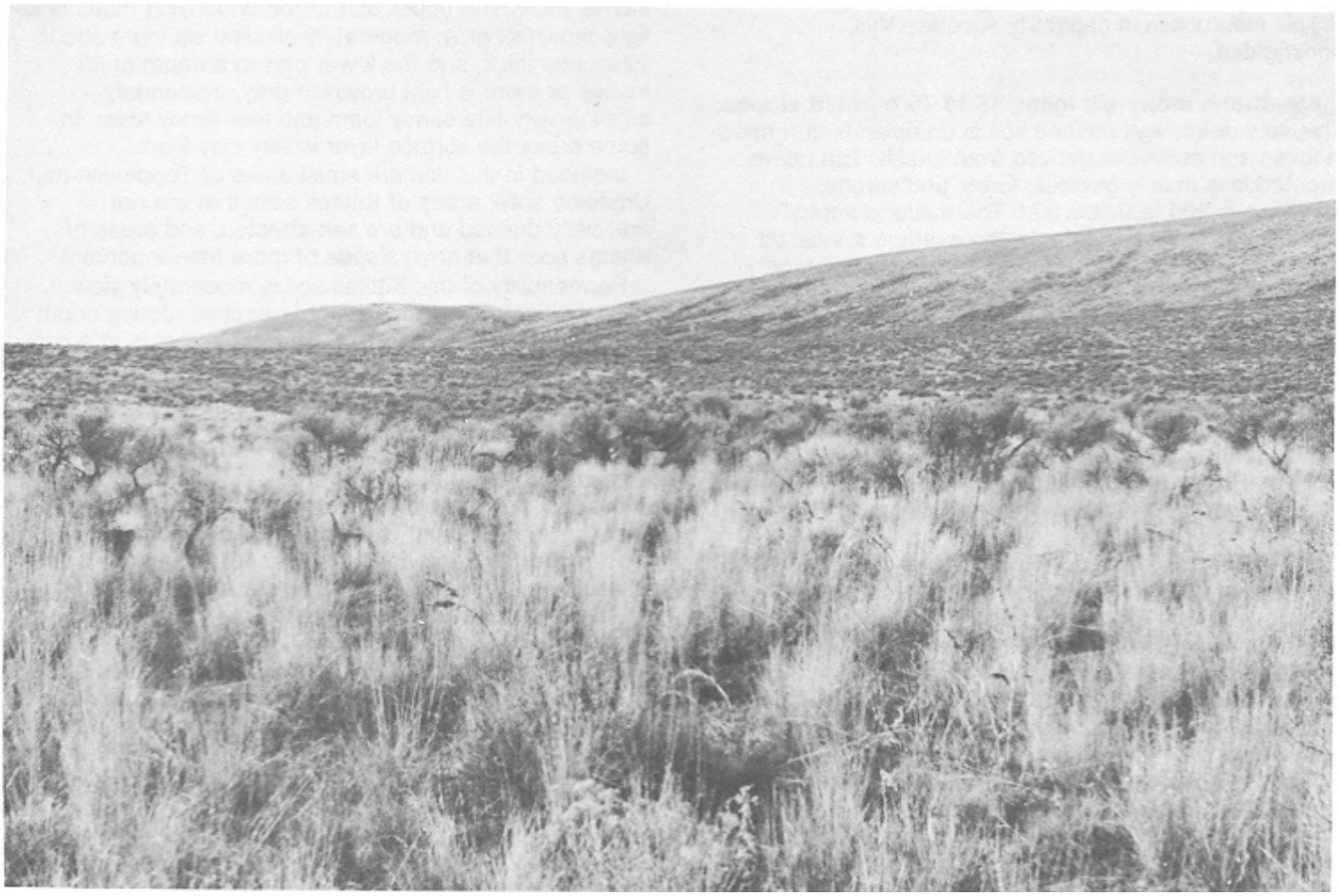

Figure 2.-Typical area of Lickskillet silt loam, 5 to 30 percent slopes, in the foreground.

brown very gravelly silt loam about 5 inches thick, and the lower part is yellowish brown very gravelly loam and very cobbly loam about 11 inches thick. Fractured basalt is at a depth of about 19 inches. Depth to basalt ranges from 12 to 20 inches. In some areas the surface layer is stony.

Included in this unit are areas of Rock Creek, Kiona, Starbuck, and Bakeoven soils.

Permeability of this Lickskillet soil is moderate. Available water capacity is low. Effective rooting depth is 12 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland, for wildlife habitat, and as homesites.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by the low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred species such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are the shallow depth to rock and steepness of slope where the slope is more than 15 percent. Bedrock hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to rock and steepness of slope. The bedrock limits the capacity of the absorption fields. Effluent from absorption fields can surface in downslope areas and thus create a hazard to health. Absorption lines need to be installed on the contour in the more nearly level areas of the unit.

This map unit is in capability subclass VIe, nonirrigated.

68-Lickskillet very stony silt loam, 5 to 45 percent slopes. This shallow, well drained soil is on uplands. It formed in loess and residuum and colluvium derived from basalt. Most slopes are about 25 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 3,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface layer is grayish brown very stony silt loam about 3 inches thick. The upper part of the subsoil is brown very gravelly silt loam about 5 inches thick, and the lower part is yellowish brown very gravelly loam and very cobbly loam about 11 inches thick. Fractured basalt is at a depth of about 19 inches. Depth to basalt ranges from 12 to 20 inches. In some areas the surface layer does not have stones.

Included in this unit are areas of Rock Creek, Kiona, Starbuck, and Bakeoven soils and areas of Rock outcrop.

Permeability of this Lickskillet soil is moderate. Available water capacity is low. Effective rooting depth is 12 to 20 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as rangeland, for wildlife habitat, and as homesites.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by the low available water capacity and large stones on the surface. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of stoniness. This unit should be seeded in fall when the moisture content of the soil is optimal, and a rangeland drill should be used. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are depth to rock and steepness of slope in areas where the slope is more than 15 percent. Bedrock hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Removal of stones might be necessary before seeding lawns.

The main limitations for septic tank absorption fields are depth to rock and steepness of slope in areas where the slope is more than 15 percent. Bedrock limits the capacity of the absorption fields. Effluent can surface in downslope areas and thus create a hazard to health. Absorption lines need to be installed on the contour in the more nearly level areas of the unit.

This map unit is in capability subclass VIIs, nonirrigated.

69-Logy silt loam, 0 to 2 percent slopes. This very deep, well drained soil is on flood plains. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,200 feet. The average annual precipitation is 7 to 10 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is dark grayish brown silt loam about 12 inches thick. The subsoil is brown extremely gravelly loam about 21 inches thick. The upper part of the substratum is brown extremely cobbly coarse sand about 12 inches thick, and the lower part to a depth of 60 inches or more is grayish brown extremely gravelly coarse sand. In some areas the surface layer is gravelly, cobbly, or stony.

Included in this unit are areas of Yakima and Weirman soils.

Permeability of this Logy soil is moderate to the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. This soil is subject to occasional periods of flooding from January to April.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Grasses and legumes are grown for hay, pasture, and seed. The main irrigated crop is grain.

The main limitation for irrigated crops is the low available water capacity. Corrugation and sprinkler irrigation systems are suited to the soil in this unit. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Water application rates should be reduced to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to avoid compaction, to maintain or improve the organic matter content, to maintain tilth, and to improve the water infiltration rate. Using vegetated filter strips at the end of rows reduces the volume of sediment in the tailwater. Exposing the extremely gravelly coarse sand substratum when leveling fields should be avoided. Shallow cuts are feasible in some areas. Dikes are effective in diverting floodwater.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the hazard of flooding. Flooding can be controlled only by use of major flood control structures. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVw, irrigated.

70-Logy cobbly silt loam, 0 to 5 percent slopes. This very deep, well drained soil is on flood plains. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,200 feet. The average annual precipitation is 7 to 10 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is dark grayish brown cobbly silt loam about 12 inches thick. The subsoil is brown extremely gravelly loam about 21 inches thick. The upper part of the substratum is brown extremely cobbly coarse sand about 12 inches thick, and the lower part to a depth of 60 inches or more is grayish brown extremely gravelly coarse sand. In some areas the surface layer does not have cobbles.

Included in this unit are areas of Logy soils that have slopes of more than 5 percent.

Permeability of this Logy soil is moderate above the subsoil and very rapid through it. Available water capacity is low. Effective rooting depth is limited by the gravelly coarse sand that is at a depth of about 45 inches. Runoff is very slow, and the hazard of water erosion is slight. This soil is subject to occasional periods of flooding from January to April.

This unit is used as rangeland and homesites and for wildlife habitat. Some small areas are used for irrigated pasture and grass or legumes.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and basin wildrye. The production of forage is limited by the large stones on the surface. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in poor condition, but it may be difficult because of cobbles. The unit should be seeded using a drill. Removal of rocks may be necessary before seeding. Adapted grasses should be seeded.

This unit is limited for livestock watering ponds and other water impoundments because of seepage. Water tanks, springs, wells, or pipeline systems can be used to provide water for livestock.

The main limitations for irrigated pasture are the low available water capacity and large stones. Sprinkler irrigation systems are suited to the soil in this unit. Use of sprinkler irrigation permits the even, controlled application of water. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Before tilling or seeding, removal of cobbles may be necessary. Dikes can be used to divert floodwater.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitations for septic tank absorption fields are the hazard of flooding and seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclasses IIIw, irrigated, and VIw, nonirrigated.

71-Loneridge stony loam, 0 to 25 percent slopes. This very deep, well drained soil is on ridges, benches, and mountaintops. It formed in residuum and colluvium derived dominantly from basalt that contains small amounts of loess. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,200 to 4,500 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is dark grayish brown stony loam about 3 inches thick. The upper part of the subsoil is pale brown very cobbly loam about 20 inches thick, and the lower part to a depth of 60 inches or more is dark yellowish brown and yellowish brown very cobbly clay.

Included in this unit are areas of Bocker soils, areas of Rock outcrop, and small convex areas of Loneridge soils that have slopes of more than 25 percent. Included areas make up about 5 percent of the total acreage.

Permeability of this Loneridge soil is moderate above the lower part of the subsoil and slow through it. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight to moderate.

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Among the trees of limited extent are western larch and grand fir. On the basis of a 100-year site curve, the mean site index is 75 for ponderosa pine and 86 for Douglas-fir. On the basis of a 50-year site curve, the mean site index for western larch is 61. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 62 cubic feet per acre for ponderosa pine at age 45 and 79 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 50 cubic feet per acre for ponderosa pine and 65 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 55 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction generally is available on this unit.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs periodically. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, Oregon-grape, pinemat manzanita, and common snowberry. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIs, nonirrigated.

72-Loneridge stony loam, 25 to 45 percent slopes. This very deep, well drained soil is on mountainsides and ridges. It formed in residuum and colluvium derived dominantly from basalt that contains small amounts of loess. Areas generally are on south-facing slopes. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 3,200 to 4,800 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is dark grayish brown stony loam about 3 inches thick. The upper part of the subsoil is pale brown very cobbly loam about 20 inches thick, and the lower part to a depth of 60 inches or more is dark yellowish brown and yellowish brown very cobbly clay.

Included in this unit are areas of Bocker soils, areas of Rock outcrop, small concave areas of Loneridge soils that have slopes of less than 25 percent, and a few areas of Loneridge soils that have short slopes of more than 45 percent. Included areas make up about 5 percent of the total acreage.

Permeability of this Loneridge soil is moderate above the lower part of the subsoil and slow through it.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Among the trees of limited extent are grand fir, lodgepole pine, and western larch. On the basis of a 100-year site curve, the mean site index is 80 for ponderosa pine, 92 for Douglas-fir, and 90 for grand fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 69 cubic feet per acre for ponderosa pine at age 40 and 88 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 55 cubic feet per acre for ponderosa pine and 75 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 80 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. Cable yarding systems may be safer, and they disturb the soil less. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction generally is available on this unit.

Seeding establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs periodically. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

Among the common forest understory plants are elk sedge, pinegrass, Oregon-grape, pinemat manzanita, lupine, and oceanspray. The crown density in the areas where the woodland site index was measured is 30 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

73-Loneridge stony loam, 25 to 45 percent north slopes. This very deep, well drained soil is on mountainsides and ridges. It formed in residuum and colluvium that are derived dominantly from basalt and contain small amounts of loess. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 2,400 to 3,400 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 135 to 160 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is dark grayish brown stony loam about 3 inches thick. The upper part of the subsoil is pale brown very cobbly loam about 20 inches thick, and the lower part to a depth of 60 inches or more is dark yellowish brown and yellowish brown very cobbly clay.

Included in this unit are areas of Bocker soils, areas of Rock outcrop, and small concave areas of Loneridge soils that have slopes of less than 25 percent or more than 45 percent. Included areas make up about 5 percent of the total acreage.

Permeability of this Loneridge soil is moderate above the lower part of the subsoil and slow through it. Available water capacity is moderate. *Effective* rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as grazable woodland and for wildlife habitat.

Douglas-fir and ponderosa pine are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 96 for Douglas-fir and 80 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 95 cubic feet per acre for Douglas-fir at age 40 and 69 cubic feet per acre for ponderosa pine at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 110 cubic feet per acre for Douglas-fir and 70 cubic feet per acre for ponderosa pine. However, the typical basal area of stands on this unit is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. Cable yarding systems may be safer, and they disturb the soil less. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction generally is available on this unit. The north-facing side slopes of this unit retain a snowpack, which delays access in spring.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and ponderosa pine occurs periodically. The droughtiness of the soil increases seedling mortality.

The common forest understory plants are pinegrass, elk sedge, lupine, oceanspray, and common snowberry. The crown density in the areas where the woodland site

index was measured is 40 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

74-McDaniel very stony loam, 5 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in loess and colluvium derived from basalt. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the surface layer is grayish brown very stony loam about 8 inches thick. The upper part of the subsoil is brown very y gravelly clay loam about 16 inches thick, and the lower part to a depth of 60 inches or more is brown very cobbly silty clay loam and yellowish brown extremely cobbly silty clay loam. In some areas the surface layer does not have stones.

Included in this unit are areas of Clint, Rock Creek, and Taneum soils and areas of Rock outcrop and McDaniel soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

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

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass and Idaho fescue. The production of forage is limited by large stones. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as balsamroot and big sagebrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Seeding is difficult because of stoniness. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIs, nonirrigated.

75-McDaniel very stony loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in loess and colluvium derived from basalt. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the surface layer is grayish brown very stony loam about 8 inches thick. The upper part of the subsoil is brown very gravelly clay loam about 16 inches thick, and the lower part to a depth of 60 inches or more is brown very cobbly silty clay loam and yellowish brown extremely cobbly silty clay loam. In some areas the surface layer does not have stones.

Included in this unit are areas of Clint, Rock Creek, and Taneum soils, areas of Rock outcrop, and areas of McDaniel soils that have slopes of less than 30 percent.

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

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass and Idaho fescue. The production of forage is limited by steepness of slope and large stones. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as balsamroot and big sagebrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chemical treatment and prescribed burning. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water tanks, and fences promotes more uniform distribution of grazing.

Seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of stoniness. Use of equipment may be difficult on the steeper slopes. The unit should be seeded in fall using a drill or by broadcasting. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

76-McDaniel-Rock Creek complex, 5 to 30 percent slopes. This map unit is on uplands. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 120 to 135 days.

This unit is about 60 percent McDaniel very stony loam and about 25 percent Rock Creek very stony silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Clint, Taneum, and Simcoe soils. Included areas make up about 15 percent of the total acreage.

The McDaniel soil is very deep and well drained. It formed in loess and in colluvium derived from basalt. Typically, the surface layer is grayish brown very stony loam about 8 inches thick. The upper part of the subsoil

is brown very gravelly clay loam about 16 inches thick, and the lower part to a depth of 60 inches or more is brown very cobbly silty clay loam and yellowish brown extremely cobbly silty clay loam. In some areas the surface layer is stony.

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

The Rock Creek soil is very shallow and well drained. It formed in loess and in residuum derived from basalt. Typically, the surface layer is grayish brown very stony silt loam about 2 inches thick. The subsoil is grayish brown and brown cobbly and very cobbly clay about 8 inches thick. Basalt is at a depth of about 10 inches. Depth to basalt ranges from 8 to 15 inches.

Permeability of the Rock Creek soil is moderately slow. Available water capacity is low. Effective rooting depth is 8 to 15 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on the McDaniel soil is mainly bluebunch wheatgrass and Idaho fescue. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as balsamroot and big sagebrush increases.

The potential native vegetation on the Rock Creek soil is mainly Sandberg bluegrass, stiff sagebrush, and eriogonum. If the range is overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases.

The production of forage on the McDaniel soil is limited by large stones. Droughtiness and depth to rock are the main limitations on the Rock Creek soil. Areas of the McDaniel soil that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Range seeding on the Rock Creek soil is not feasible because of the very shallow soil depth and soil droughtiness. Range seeding on the McDaniel soil is a suitable practice if the range vegetation is in poor condition, but it is difficult because of stoniness. The soil should be seeded in fall using a drill or by broadcasting. Adapted grasses and legumes should be seeded on this unit.

This map unit is in capability subclass VIIs, nonirrigated.

77-Meystre loam, 0 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in loess and in material weathered from sandstone. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 20 inches, the average annual air temperature is about 48 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 175 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is grayish brown and dark grayish brown loam about 11 inches thick. The subsoil is brown and yellowish brown clay loam and light yellowish brown fine sandy loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown fine sandy loam. In some areas the subsoil is clay.

included in this unit are small areas of Taneum and Odo soils and areas of Meystre soils that have slopes of more than 15 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Among the trees of limited extent is Oregon white oak. On the basis of a 100-year site curve, the mean site index is 63 for ponderosa pine and 74 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 49 cubic feet per acre for ponderosa pine at age 55 and 61 cubic feet per acre for Douglas-fir at age 45. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre for ponderosa pine and 50 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 80 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. Wheeled and tracked equipment can be used in skidding operations. Use of such equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trials are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. The droughtiness of the soil increases seedling mortality, especially on south- and southwest- facing slopes.

The common forest understory plants are elk sedge, pinegrass, Idaho fescue, lupine, antelope bitterbrush, and Oregon-grape. The crown density in the areas where the

woodland site index was measured is 35 percent. This unit is well suited to grazing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass IIIe, nonirrigated.

78-Meystre stony loam, 15 to 45 percent slopes. This very deep, well drained soil is on uplands. It formed in loess and in material weathered from sandstone. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 20 inches, the average annual air temperature is about 48 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 175 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is grayish brown and dark grayish brown stony loam about 11 inches thick. The subsoil is brown and yellowish brown clay loam and light yellowish brown fine sandy loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown fine sandy loam.

Included in this unit are areas of Taneum and Odo soils and areas of Meystre soils that have slopes of less than 15 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 63 for ponderosa pine and 74 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 49 cubic feet per acre for ponderosa pine at age 55 and 61 cubic feet per acre for Douglas-fir at age 45. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 35 cubic feet per acre for ponderosa pine and 50 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 80 percent that of normal stands, and the total yield is correspondingly lower.

The main limitations for the harvesting of timber are a short period of seasonal soil wetness and steepness of slope. Wheeled and tracked equipment can be used in skidding operations. Use of such equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots, especially on parts of the unit that have slopes of more than 30 percent. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, Oregon-grape, ceanothus, and common snowberry. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIs, nonirrigated.

79-Mikkalo silt loam, 0 to 5 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is brown silt loam about 15 inches thick. The upper part of the substratum is pale brown silt loam about 6 inches thick, and the lower part is pale brown gravelly silt loam about 4 inches thick. Basalt is at a depth of about 30 inches. Depth to basalt ranges from 20 to 40 inches.

Included in this unit are areas of Starbuck soils, Ritzville soils that are underlain by basalt, and Willis soils.

Permeability of this Mikkalo soil is moderate. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitation for nonirrigated crops is low annual precipitation. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and stripcropping. Drainageways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Cusick bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage

plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is depth to rock, which hinders excavation. Dustiness can be a problem during construction of large building Sites; therefore these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the depth to rock limits the capacity of the absorption fields. The use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IVe, nonirrigated.

80-Mikkalo silt loam, 5 to 15 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is brown silt loam about 15 inches thick. The upper part of the substratum is pale brown silt loam about 6 inches thick, and the lower part is pale brown gravelly silt loam about 4 inches thick. Basalt is at a depth of about 30 inches. Depth to basalt ranges from 20 to 40 inches.

Included in this unit are areas of Starbuck soils, Ritzville soils that are underlain by basalt, and Willis soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Mikkalo soil is moderate. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for nonirrigated cropland, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, tilling on the contour or across the slope, using terraces, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grasses.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Cusick bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in pour condition. The unit Should be weeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is depth to rock, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the depth to rock. Bedrock limits the capacity of the absorption field. The use of long absorption lines helps to compensate for this limitation. Slope can promote lateral seepage and surfacing of the effluent in downslope areas. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVe, nonirrigated.

81-Mikkalo silt loam, 15 to 30 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is from 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is brown silt loam about 15 inches thick. The upper part of the substratum is pale brown silt loam about 6 inches thick, and the lower part is pale brown gravelly silt loam about 4 inches thick. Basalt is at a depth of about 30 inches. Depth to basalt ranges from 20 to 40 inches.

Included in this unit are areas of Starbuck soils, Ritzville soils that are underlain by basalt, and Willis soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Mikkalo soil is moderate. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be

reduced by seeding fall grain early, stubble mulching, and tilling and seeding on the contour or across the slope. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grasses.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Cusick bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable shrubs can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded. This unit is poorly suited to homesite development. The main limitations are the moderate depth to rock and steepness of slope. The bedrock hinders excavation. Dustiness can be a problem during construction on large building sites; therefore these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are the moderate depth to rock and steepness of slope. The moderate depth to bedrock limits the capacity of the absorption fields and, along with slope, can promote lateral seepage and surfacing of effluent in downslope areas. Use of long absorption lines helps to compensate for the moderate depth to bedrock. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVe, nonirrigated.

82-Mippon very cobbly silt loam. This very deep, well drained soil is on low terraces and flood plains. It formed in recent alluvium. Slope is 0 to 5 percent. Areas are long and narrow. They are characterized by old dry streambeds. The native vegetation is mainly coniferous and deciduous trees, grasses, forbs, and shrubs. Elevation is 2,400 to 4,800 feet. The average annual precipitation is 20 to 40 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1/2 inch thick. The upper 7 inches of the surface layer is very dark grayish brown very cobbly silt loam, and the lower 7 inches is dark grayish brown very cobbly loam. The substratum to a depth of 60 inches or more is brown and yellowish brown extremely gravelly sand. In some areas the surface layer is stony or extremely cobbly, the substratum is loam or sandy loam, or the soil is mottled and has a seasonal high water table in the lower part of the substratum.

Included in this unit are areas of riverwash along stream channels and in old dry streambeds. Also included are areas of poorly drained soils in depressional areas. Included areas make up about 15 percent of the total acreage.

Permeability of this Mippon soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. A seasonal high water table is at a depth of 36 to 60 inches during February to April. This soil is subject to occasional periods of flooding from March to May. Channeling and deposition are common along streambanks.

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main coniferous species at the lower elevations on this unit. Grand fir is the predominant coniferous species above an elevation of 3,000 feet. Trees of limited extent include western larch, lodgepole pine, and Engelmann spruce. On the basis of a 100-year site curve, the mean site index is 108 for ponderosa pine, 113 for Douglas-fir, 104 for grand fir, and 87 for lodgepole pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at age 40 is 118 cubic feet per acre for ponderosa pine and 128 cubic feet per acre for Douglas-fir. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 105 cubic feet per acre for ponderosa pine and 135 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 85 percent that of normal stands, and the total yield is correspondingly lower.

The main limitations for the harvesting of timber are the uneven, broken topography, occasional periods of flooding, and the very cobbly surface layer. Use of equipment is limited by the occasional periods of flooding in spring. Routes for roads and skid trails commonly are restricted by old stream channels. Leveling and grading the surface layer generally are adequate for road construction on this unit. Extra caution is required during felling and yarding to prevent damage to streambeds, streambanks, and riparian vegetation. The large volume of cobbles in the surface layer increases the wear of wheeled and tracked equipment.

Plant competition is the main concern in the production of timber. Varying amounts of black cottonwood, mountain alder, quaking aspen, redosier dogwood, and willow are in the included areas of this unit. These brushy plants can invade openings on the Mippon soil in this unit and, unless controlled, delay reforestation. The droughtiness of the surface layer during the dry summer months increases seedling mortality. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees

are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs periodically.

The common forest understory plants are oceanspray, common snowberry, elderberry, currant, rose, redosier dogwood, and elk sedge. The crown density in the areas where the woodland site index was measured is 30 percent. This unit is well suited to grazing and browsing. If the understory is overgrazed, the proportion of preferred forage plants such as elk sedge decreases and the proportion of less desirable forbs and annual grasses increases. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass Vlw, nonirrigated.

83-Moxee silt loam, 2 to 15 percent slopes. This well drained soil is on uplands. It is shallow over a hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil is pale brown silt loam about 4 inches thick. The substratum is pale brown gravelly silt loam about 7 inches thick. A lime- and silica-cemented hardpan is at a depth of about 18 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Starbuck, Selah, Roza, Willis, and Gorst soils.

Permeability of this Moxee soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated pasture and hay, rangeland (fig. 3), wildlife habitat, and homesites.

The main limitations for irrigated pasture and hay are steepness of slope, depth to the hardpan, and the hazard of water erosion. Using a cropping system that includes close-growing crops in the rotation reduces water erosion. Sprinkler irrigation systems are well suited to the soil in this unit. Use of these systems permits the even, controlled application of irrigation water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

The potential native vegetation on this unit is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by the depth to the hardpan. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is the shallow depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the shallow depth to the hardpan, which limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclasses IVe, irrigated, and Vle, nonirrigated.

84-Moxee silt loam, 15 to 30 percent slopes. This well drained soil is on uplands. It is shallow over a hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil is pale brown silt loam about 4 inches thick. The substratum is pale brown gravelly silt loam about 7 inches thick. A lime- and silica-cemented hardpan is at a depth of about 18 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt.

Included in this unit are small areas of Starbuck, Willis, Selah, and Gorst soils and areas of Moxee soils that have slopes of more than 30 percent.

Permeability of this Moxee soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated hay and pasture, for wildlife habitat, and as homesites.

The main limitations for irrigated hay and pasture are steepness of slope, depth to the hardpan, and the hazard of water erosion. Using a cropping system that includes close-growing crops in the rotation reduces water erosion. Sprinkler irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Figure 3.-Rangeland on Moxee silt loam, 2 to 15 percent slopes, in the foreground.

This unit is poorly suited to homesite development. The main limitations are the shallow depth to the hardpan and steepness of slope. The pan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan and steepness of slope. The pan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass Vle, irrigated.

85-Moxee cobbly silt loam, 0 to 30 percent slopes. This well drained soil is on uplands. It is shallow over a hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is brown cobbly silt loam about 7 inches thick. The subsoil is pale brown silt loam about 4 inches thick. The substratum is pale brown gravelly silt loam about 7 inches thick. A lime- and silica-cemented hardpan is at a depth of about 18 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt.

Included in this unit are areas of Starbuck and Gorst soils.

Permeability of this Moxee soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is medium, large stones, and the hazard of water erosion is moderate.

This unit is used for irrigated hay and pasture, rangeland, wildlife habitat, and homesites.

The main limitations for irrigated hay and pasture are steepness of slope, depth to the hardpan, large stones, and the hazard of water erosion. Sprinkler irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Growing perennial hay and pasture reduces erosion. Seedbed preparation is difficult, and removal of stones might be necessary.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by large stones and the low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and cheatgrass increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of the cobbles in the surface layer. Removal of stones may be needed before seeding. The unit should be seeded in the fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are the shallow depth to the hardpan, steepness of slope, and large stones, which hinder excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. The cobbly surface makes the establishment of lawns difficult.

The main limitations for septic tank absorption fields are depth to the hardpan and steepness of slope. The hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of the effluent in downslope areas. Absorption lines should be installed on the contour.

This map unit is in capability subclass Vle, nonirrigated and irrigated.

86-Naches loam. This very deep, well drained soil is on stream terraces in valleys. It formed in old alluvium. Slope is 0 to 2 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 900 feet. The average annual precipitation is 7 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 12 inches thick, and the lower part is yellowish brown loam about 7 inches thick. The upper part of the substratum is yellowish brown gravelly loam about 6 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown extremely gravelly sand. In some areas the surface layer is gravelly, and in some areas the substratum is extremely gravelly to a depth of about 38 inches or more.

Included in this unit are small areas of Esquatzel, Ashue, and Yakima soils.

Permeability of this Naches soil is slow above the lower part of the substratum and very rapid through it. Available water capacity is moderately high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

This unit has few limitations for irrigated crops. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil is this unit. The type of system used depends on the kind of crop grown. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIs, irrigated.

87-Naxing loam, 5 to 25 percent slopes. This very deep, well drained soil is on mountaintops and broad mountain ridges. It formed in colluvium that is derived dominantly from basalt and contains small amounts of loess and volcanic ash. The native vegetation is mainly conifers, forbs, and shrubs. Elevation is 5,000 to 7,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, is 80 to 110 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is brown loam about 14 inches thick. The subsoil is yellowish brown very cobbly loam about 7 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam. In some areas the surface layer is stony.

Included in this unit are areas of Cryandepts in swales and on alluvial fans, Saydab soils on ridgetops, Darland soils on south-facing side slopes, and Naxing soils that have slopes of more than 25 percent. Also included are soils, on cirque floors, that have a glacial till substratum. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Subalpine fir, lodgepole pine, and Engelmann spruce are the main woodland species on this unit. Among the trees of limited extent are whitebark pine and western larch. Western larch and lodgepole pine commonly occur in small, densely stocked stands. On the basis of a 100-year site curve, the mean site index is 70 for lodgepole pine, 68 for subalpine fir, and 74 for Engelmann spruce. Yield tables for normal, even-aged, unmanaged stands of lodgepole pine at 100 years of age indicate that the mean annual increment at culmination (CMAI) is 70 cubic feet per acre. On the basis of a 50-year site curve, the mean site index for western larch is 55. Yield tables for normal, even-aged, unmanaged stands of western larch indicate that the mean annual increment at culmination for trees 0.6 inch in diameter and larger at 70 years of age is 72 cubic feet per acre. The mean annual increment for western larch trees 7.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre. However, the typical basal area of stands on this unit is about 125 percent that of normal stands, and total yield is correspondingly higher. The site index is quite variable on this unit. The highest site indexes generally are at the lower elevations on south-facing slopes, and the lowest site indexes are at the higher elevations on north-facing slopes.

The main limitation for the harvesting of timber is snowpack, which hinders the use of equipment and limits access in winter. Wheeled and tracked equipment can be used in skidding operations. Unsurfaced roads and skid trails are soft and slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in some areas of this unit.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by subalpine fir and lodgepole pine occurs periodically. Low soil temperatures, heavy snowpack, and the short growing season limit the even distribution of natural reforestation, especially on north-facing slopes. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest- facing slopes.

The common forest understory plants are elk sedge, pinegrass, lupine, vetch, and dwarf huckleberry. The crown density in the areas where the woodland site index was measured is 40 percent. This unit is well suited to grazing and browsing. It has few limitations for the production of forage. If the understory is overgrazed, the proportion of preferred forage plants such as elk sedge decreases and the proportion of less desirable forbs and annual grasses increases. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This unit is limited for livestock watering ponds and other water impoundments because of seepage. Spring developments, wells, or pipeline systems can be used to provide stock water.

This map unit is in capability subclass VIe, nonirrigated.

88-Naxing stony loam, 25 to 45 percent slopes. This very deep, well drained soil is on mountainsides. It formed in colluvium that is derived dominantly from basalt and contains loess and volcanic ash. The native vegetation is mainly conifers, forbs, and shrubs. Elevation is 5,000 to 7,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, is 80 to 110 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is brown stony loam about 14 inches thick. The subsoil is yellowish brown very cobbly loam about 7 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam.

Included in this unit are areas of Saydab soils on ridgetops, areas of Darland soils on south-facing side slopes, areas of Rock outcrop, and areas of Naxing soils that have slopes of less than 25 percent or more than 45 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Western larch, subalpine fir, and lodgepole pine are the main woodland species on this unit. Among the trees of limited extent are grand fir, Engelmann spruce, and whitebark pine. On the basis of a 50-year site curve, the

mean site index for western larch is 52. Yield tables for normal, even-aged, unmanaged stands of western larch indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 70 years of age is 67 cubic feet per acre. The mean annual increment for western larch trees 7.6 inches in diameter and larger at 80 years of age is 35 cubic feet per acre. On the basis of a 100-year site curve, the mean site index is 85 for lodgepole pine, 75 for subalpine fir, and about 74 for Engelmann spruce. Yield tables for normal, even-aged, unmanaged stands of lodgepole pine at 100 years of age indicate that the mean annual increment at culmination is about 97 cubic feet per acre. However, the typical basal area of stands on this unit is about 95 percent that of normal stands, and the total yield is correspondingly lower. The site index is quite variable on this unit. The highest site indexes generally are at the lower elevations on south-facing slopes, and the lowest site indexes are at the higher elevations on north-facing slopes.

The main limitations for the harvesting of timber are snowpack and steepness of slope. Snowpack hinders the use of equipment and limits access in winter. North-facing side slopes retain snowpack longer, which delays access in spring. Steepness of slope makes the use of wheeled and tracked equipment difficult. Cable yarding systems may be safer, and they disturb the soil less. Unsurfaced roads and skid trails are soft and slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in some areas of this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by subalpine fir and western larch occurs periodically. Low soil temperatures, deep snowpack, and the short growing season limit the even distribution of natural reforestation, especially on north-facing slopes. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, lupine, vetch, currant, and dwarf huckleberry. The crown density in the areas where the woodland site index was measured is 40 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This unit is limited for livestock watering ponds and other water impoundments because of seepage. Spring developments, wells, or pipeline systems can be used to provide stock water.

This map unit is in capability subclass VIIs, nonirrigated.

89-Naxing stony loam, 45 to 65 percent slopes. This very deep, well drained soil is on mountainsides. It formed in colluvium that is derived dominantly from basalt and contains loess and volcanic ash. The native vegetation is mainly conifers, forbs, and shrubs. Elevation is 5,000 to 7,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, is 80 to 110 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The surface layer is brown stony loam about 14 inches thick. The subsoil is yellowish brown very cobbly loam about 7 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely cobbly loam.

Included in this unit are Saydab soils on ridgetops, Darland soils on south-facing side slopes, areas of Rock outcrop, and Naxing soils on concave slopes of less than 45 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Naxing soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and hazard of water erosion is moderate.

This unit is used as grazable woodland and for wildlife habitat.

Subalpine fir, Engelmann spruce, and western larch are the main woodland species on this unit. Among the trees of limited extent are whitebark pine, Douglas-fir, and grand fir. On the basis of a 50-year site curve, the mean site index for western larch is 52. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 70 years of age is 67 cubic feet per acre. The mean annual increment for trees 7.6 inches in diameter and larger at 80 years of age is 35 cubic feet per acre. However, the typical basal area of stands on this unit is about 90 percent that of normal stands, and the total yield is correspondingly lower. On the basis of 100-year site curve, the site index is 59 for subalpine fir and about 74 for Engelmann spruce. The site index is quite variable on this unit. The highest site indexes generally are at the lower elevations on south-facing slopes, and the lowest site indexes are at the higher elevations on north-facing slopes.

The main limitations for the harvesting of timber are snowpack and steepness of slope. Snowpack hinders the use of equipment and limits access in winter. North-facing side slopes retain snowpack longer, which delays access in spring. Steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems are safer and disturb the soil less. Unsurfaced roads and skid trails are soft and slippery

when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in some areas of this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by subalpine fir and Engelmann spruce occurs periodically. Low soil temperatures, deep snowpack, and the short growing season increase seedling mortality and limit the even distribution of natural reforestation, especially on north-facing slopes. The droughtiness of the surface layer during the dry summer months increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, lupine, vetch, currant, pinemat manzanita, and dwarf huckleberry. The crown density in the areas where the woodland site index was measured is 30 percent. This unit is well suited to browsing. Steepness of slope limits access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or inn fall generally is most successful. Because of the steepness of slope, broadcast seeding should be used.

This unit is limited for livestock watering ponds and other water impoundments because of seepage potential. Spring developments, wells, or pipeline systems can be used to provide stock water.

This map unit is in capability subclass VIIs, nonirrigated.

90-Odo cobbly silt loam, 5 to 35 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum and colluvium that is derived dominantly from basalt and contains some loess and volcanic ash. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,000 to 3,200 feet. The average annual precipitation is 15 to 19 inches, the average annual air temperature is about 46 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 180 days.

Typically, the surface is covered with a mat of decomposing organic material about 3 inches thick. The surface layer is brown cobbly silt loam about 18 inches thick. The subsoil to a depth of 60 inches or more is yellowish brown gravelly loam. In some areas the subsoil is very gravelly or very cobbly.

Included in this unit are areas of Meystre, Rock Creek, Clint, and Tekison soils. Included areas make up about 10 percent of the total acreage.

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

The unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Among the trees of limited extent are Oregon white oak and Rocky Mountain maple. On the basis of a 100-year site curve, the mean site index is 75 for ponderosa pine and 96 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 62 cubic feet per acre for ponderosa pine at age 45 and 95 cubic feet per acre for Douglas fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 50 cubic feet per acre for ponderosa pine and 80 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trails are soft and slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. Where seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. Droughtiness of the soil increases seedling mortality, especially on south- and southwest- facing slopes.

The common forest understory plants are elk sedge, pinegrass, bitterbrush, common snowberry, and Oregon white oak. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass IVe, nonirrigated.

91-Outlook fine sandy loam. This very deep, artificially drained soil is on flood plains. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly alkali-tolerant grasses and shrubs. Elevation is 650 to 2,000 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is 51 degrees F, and the average frost-free season is 130 to 160 days.

Typically, the surface layer is very dark grayish brown, dark grayish brown, and very dark brown fine sandy loam about 8 inches thick and has yellowish brown or dark yellowish brown mottles. It is strongly alkaline. The subsoil is grayish brown, mottled silt loam about 10

inches thick. The substratum to a depth of 60 inches or more is dark brown silt loam. The subsoil and substratum are moderately alkaline.

Included in this unit are small areas of Umapine and Sinloc soils and areas of Outlook soils that have not been artificially drained.

Permeability of this Outlook soil is moderate. Available water capacity is high. Effective rooting depth is limited by a high water table that is at a depth of 24 to 48 inches from May to December. Runoff is ponded, and the hazard of erosion is slight. The hazard of soil blowing is high. This soil is partially protected from flooding, and the hazard of flooding is rare.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. In areas that have been drained, leached, and irrigated, the main crops are asparagus, corn, grain, hops, and mint. Grasses and legumes are grown for hay, pasture, and seed. Deep-rooted crops are suited to areas where the drainage is adequate or where a drainage system has been installed and is adequately maintained.

The main limitations for irrigated crops are wetness, high alkalinity, and the hazard of soil blowing. Dikes can be used to divert floodwater. Reclamation may require the addition of such amendments as gypsum, sulfur, or ferric sulfate to facilitate leaching.

Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of sprinkler irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

The initial period of irrigation following cultivation is the most critical one for the control of erosion. The hazard of soil blowing makes proper tillage and crop residue management extremely important. This unit should be protected with plant cover or residue during the period of susceptibility to soil blowing in spring. Seedbeds should be prepared when irrigation water is available to saturate the soil surface. Use of straw, manure, or other waste material as a mulch reduces soil blowing.

Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the amount of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling when the soil is dry.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and soil wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Plants selected for use as ground cover should be alkali tolerant.

The main limitation for septic tank absorption fields is wetness.

This map unit is in capability subclass IIIw, irrigated.

92-Outlook silt loam. This very deep, artificially drained soil is on flood plains. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is alkali-tolerant grasses and shrubs. Elevation is 650 to 2,000 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is 51 degrees F, and the average frost-free season is 130 to 160 days.

Typically, the surface layer is very dark brown, very dark grayish brown and dark grayish brown silt loam about 8 inches thick and has yellowish brown or dark yellowish brown mottles. It is strongly alkaline. The subsoil is grayish brown, mottled silt loam about 10 inches thick. The substratum to a depth of 60 inches or more is dark brown silt loam. The subsoil and substratum are moderately alkaline.

Included in this unit are small areas of Umapine and Sinloc soils and areas of Outlook soils that have not been artificially drained.

Permeability of this Outlook soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 48 inches. Runoff is ponded, and the hazard of water erosion is slight. This unit is partially protected from flooding, and the hazard of flooding is rare.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Where the soil is this unit is drained, leached, and irrigated, the main crops are asparagus, corn, grain, hops, and mint. Grasses and legumes are grown for hay, pasture, and seed. Deep-rooted crops are suited to areas where the drainage is adequate or where a drainage system has been installed and is adequately maintained.

The main limitations for irrigated crops are the hazard of water erosion and the high content of alkali. Dikes can be used to divert floodwater. Reclamation may require the addition of such amendments as gypsum, sulfur, or ferric sulfate to facilitate leaching.

Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of sprinkler irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely

critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Proper timing of minimum tillage and return of crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in the soil in this unit; however, it can be broken by chiseling and subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and soil wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Plants selected for ground cover need to be alkali tolerant.

The main limitation for septic tank absorption fields is wetness.

This map unit is in capability subclass IIIw, irrigated.

93-Pits. This unit consists primarily of gravel pits, areas used for sanitary landfills, and areas used as a source of clay.

Most of the gravel pits are in areas of Weirman soils along the Yakima and Naches Rivers. These pits are mainly used as a source of material for roadfill and for surfacing roads and as a source of sand and gravel for use in concrete. Some gravel pits are in areas of Ashue and Scooteney soils and in areas of Harwood, Burke, and Wiehl soils on uplands. The Harwood and Burke soils, along with included areas of Gorst and Scoon soils, have a hardpan that contains gravel. The hardpan can be ripped and the material used as roadfill and for surfacing roads.

This map unit is in capability subclass VIIIs, nonirrigated.

94-Prosser silt loam, 0 to 15 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess and alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 300 to 1,150 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typically, the surface layer is brown silt loam about 4 inches thick. The subsoil is pale brown silt loam about 10 inches thick. The substratum is pale brown and light gray silt loam about 19 inches thick. Basalt is at a depth of about 33 inches. Depth to basalt ranges from 20 to 40 inches.

Included in this unit are areas of Mikkalo, Shano, and Starbuck soils.

Permeability of this Prosser soil is moderate. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for nonirrigated crops, as rangeland, and for wildlife habitat.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation on this unit is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, chemical treatment, and prescribed burning.

Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass IVe, nonirrigated.

95-Quincy loamy fine sand, 0 to 10 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in eolian sand. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 49 degrees F, and the frost-free season is 135 to 180 days.

Typically, the surface layer is grayish brown loamy fine sand about 20 inches thick. The underlying material to a depth of 60 inches or more is grayish brown medium sand.

Included in this unit are small areas of Esquatzel, Warden, and Hezel soils and areas of Quincy soils that have the slopes of more than 10 percent. Also included are areas of alkali-affected soils that are somewhat poorly drained and soils that are underlain by basalt,

gravel, or lacustrine sediment at a depth of 40 inches or more.

Permeability of this Quincy soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and hazard of water erosion is slight. The hazard of soil blowing is high.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain, potatoes, corn, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are rapid permeability, low available water capacity, steepness of slope, and the hazard of soil blowing. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water. Because this soil is droughty, frequent, light applications of irrigation water are needed. To avoid leaching of plant nutrients and loss of water, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

This unit should be protected with a cover crop during periods when it is susceptible to soil blowing, and it should be protected by crop residue until crops are well established in spring. To provide adequate cover in winter, fall grain, hay, or pasture should be seeded late in August or early in September.

Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce erosion. Use of straw, manure, or other waste material as a mulch reduces soil blowing, helps to maintain or improve the organic matter content, and conserves moisture. Seedbeds should be prepared when irrigation water is available to keep the soil surface moist. Vegetative barriers and shelterbelts can be used to control soil blowing.

This unit is well suited to homesite development. Soil blowing can be a problem on large construction sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IVe, irrigated.

96-Renslow silt loam, 5 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,500 to 2,800. The average annual precipitation is 10 to 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is grayish brown and brown silt loam about 23 inches thick. The substratum to a depth of 60 inches or more is pale brown silt loam. In some areas basalt is at a depth of more than 40 inches.

Included in this unit are areas of Starbuck, Mikkalo, and Willis soils and areas of Renslow soils that have slopes of less than 5 percent.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are the low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, steepness of slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour or across the slope.

This map unit is in capability subclass IIIe, nonirrigated.

97-Renslow silt loam, basalt substratum, 0 to 5 percent slopes. This deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,500 to 2,800 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is grayish brown and brown silt loam about 23 inches thick. The substratum is pale brown silt loam about 14 inches thick. Basalt is at a depth of about 44 inches. Depth to basalt ranges from 40 to 60 inches. In some areas basalt is at a depth of more than 60 inches.

Included in this unit are areas of Mikkalo, Rock Creek, Starbuck, and Ritzville soils.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are the low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, shaping and seeding waterways to perennial grass, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for homesites is the moderate depth to bedrock, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the moderate depth to bedrock limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. In areas where the bedrock is fractured, contamination of ground water by unfiltered effluent is possible.

This map unit is in capability subclass IIIe, nonirrigated.

98-Renslow silt loan, basalt substratum, 5 to 15 percent slopes. This deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,500 to 2,800 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is grayish brown and brown silt loam about 23 inches thick. The substratum is pale brown silt loam about 14 inches thick. Basalt is at a depth of 44 inches. Depth to basalt ranges from 40 to 60 inches. In some areas basalt is at a depth of more than 60 inches.

Included in this unit are areas of Mikkalo, Ritzville, Rock Creek, Starbuck, and Willis soils.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitations are moderate depth to bedrock and steepness of slope. The bedrock hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are moderate depth to bedrock and steepness of slope. The moderate depth to bedrock limits the capacity of the absorption fields. Slope can cause lateral seepage and

surfacing of effluent in downslope areas. Absorption lines should be placed on the contour or across the slope. Where the bedrock is fractured, contamination of ground water by unfiltered effluent is possible.

This map unit is in capability subclass IIIe, nonirrigated.

99-Ritzville silt loam, 2 to 5 **percent slopes.** This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown and pale brown silt loam. In some areas basalt, a hardpan, or old alluvium is at a depth of more than 40 inches.

Included in this unit are small areas of Mikkalo, Selah, Willis, Harwood, Esquatzel, and Tieton soils and areas of Ritzville soils that have slopes of less than 2 percent.

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

This unit is used for irrigated and nonirrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are asparagus, corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from over irrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows greatly reduces water erosion. A plowpan develops in the soil in this unit; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by shaping waterways and seeding them to perennial grass. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Dustiness can be a problem during construction on large building sites. Therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclasses IIe, irrigated and IIIe, nonirrigated.

100-Ritzville silt loam, 5 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown and pale brown silt loam. In some areas basalt, a hardpan, or old alluvium is at a depth of more than 40 inches.

Included in this unit are small areas of Selah, Willis, Harwood, and Tieton soils.

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

This unit is used for irrigated field and orchard crops and as rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Cover crops are needed in orchards and vineyards to reduce erosion. A plowpan develops in the soil in this unit; however, it can be broken by chiseling or subsoiling when the soil is dry.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This map unit is in capability subclass IIIe, irrigated and nonirrigated.

101-Ritzville silt loam, 8 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. T he subsoil is brown or pale brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown and pale brown silt loam. In some areas basalt, a hardpan, or old alluvium is at a depth of more than 40 inches.

Included in this unit are areas of Selah, Willis, Harwood, and Tieton soils. areas of Rock outcrop, and areas of Ritzville soils that have slopes of less than 8 percent.

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

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grasses, legumes, grapes, and tree fruit. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to. the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Tillage should be across the slope or on the contour. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing annual or perennial cover crops reduces erosion in orchards and vineyards. A plowpan develops in the soil in this unit; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is steepness of slope, which can cause lateral seepage and surfacing of effluent in downslope areas. Absorption lines should be installed on the contour or across the slope.

This map unit is in capability subclasses IVe, irrigated, and IIIe, nonirrigated.

102-Ritzville silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown and pale brown silt loam. In some areas basalt, a hardpan, or old alluvium is at a depth of more than 40 inches.

Included in this unit are small areas of Selah, Willis, Harwood, and Tieton soils.

Permeability of this Ritzville soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grasses, legumes, grapes, and tree fruit (fig. 4). A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Growing perennial cover in orchards and vineyards reduces erosion. A plowpan develops in the soil in this unit; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and divided-slope farming. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable shrubs can be improved by such methods as railing, chaining, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Dustiness can

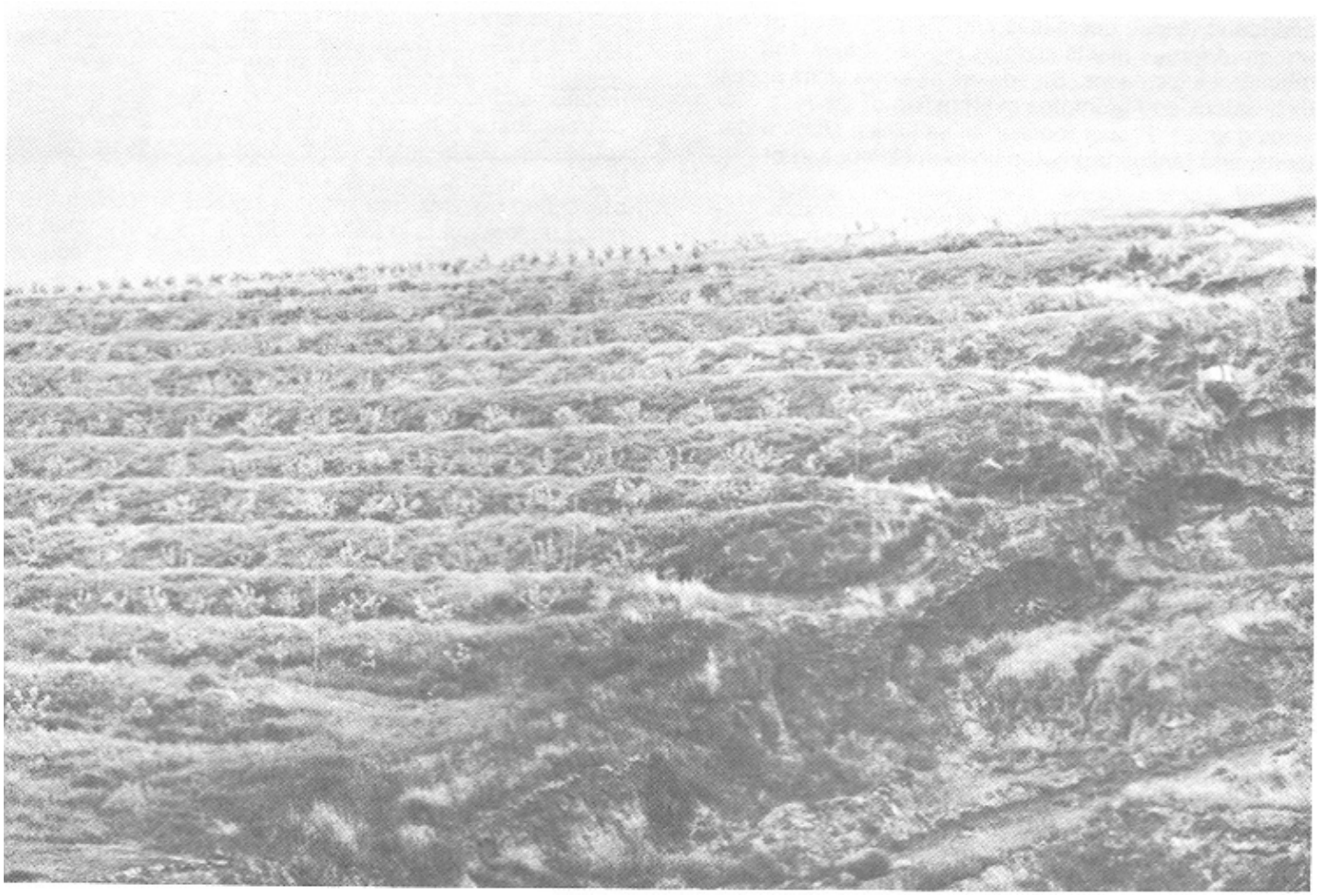

Figure 4.-New fruit trees on terraces of Ritzville silt loam, 15 to 30 percent slopes.

be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is steepness of slope. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour or across the slope.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

103-Ritzville silt loam, 30 to 60 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown and pale brown silt loam. In some areas the surface layer is calcareous.

Included in this unit are Mikkalo, Starbuck, Willis, and Kiona soils. Included areas make up about 15 percent of the total acreage.

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

This unit is used as rangeland and for wildlife habitat. The potential vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed the proportion of preferred forage plants such as bluebunch wheatgrass

and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water tanks, and fences promotes uniform distribution of grazing.

Areas that are heavily infested with undesirable vegetation can be improved by chemical treatment and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. Use of equipment may be difficult in the more steeply sloping areas. The unit should be seeded in fall using aerial methods. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIe, nonirrigated.

104-Ritzville silt loam, basalt substratum, 0 to 5 percent slopes. This deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum is light yellowish brown silt loam about 8 inches thick. Basalt is at a depth of about 45 inches. Depth to bedrock ranges from 40 to 60 inches. In some areas a lime- and silica-cemented hardpan is at a depth of more than 40 inches, and in some areas depth to basalt is 60 inches or more.

Included in this unit are small areas of Mikkalo, Willis, and Esquatzel soils. Included areas make up about 15 percent of the total acreage.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, and shaping waterways and seeding them to perennial grass. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation is moderate depth to rock, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is moderate depth t_o rock, which limits the capacity of the absorption fields. The use of long absorption lines helps to compensate for this limitation. Where the bedrock is fractured, contamination of ground water by unfiltered effluent is possible.

This map unit is in capability subclass IIIe, nonirrigated.

105-Ritzville silt loam, basalt substratum, 5 to 15 percent slopes. This deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum is light yellowish brown silt loam about 8 inches thick. Basalt is at a depth of about 45 inches. Depth to basalt ranges from 40 to 60 inches. In some areas a lime- and silica-cemented hardpan is at a depth of more than 40 inches, and in some areas depth to basalt is 60 inches or more.

Included in this unit are areas of Mikkalo and Willis soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Ritzville soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 50 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

These main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces

erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbit brush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitations are steepness of slope and depth to rock, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to rock and steepness of slope. The depth to rock restricts the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Where the bedrock is fractured, contamination of ground water by unfiltered effluent is possible. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour or across the slope.

This map unit is in capability subclass IIIe, nonirrigated.

106-Ritzville silt loam, basalt substratum, 15 to 30 percent slopes. This deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is brown or pale brown silt loam about 30 inches thick. The substratum is light yellowish brown silt loam about 8 inches thick. Basalt is at a depth of about 45 inches. Depth to basalt ranges from 40 to 60 inches. In some areas a lime- and silica-cemented hardpan is at a depth of more than 40 inches, and in some areas depth to basalt is 60 inches or more.

Included in this unit are areas of Mikkalo and Willis soils. Included areas make up about 15 percent of the total acreage.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is steepness of slope, which can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour or across the slope. Where the underlying basalt is fractured, contamination of ground water by unfiltered effluent is possible.

This map unit is in capability subclass IVe, nonirrigated.

107-Ritzville Variant silt loam, 5 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in loess overlying cobbly or gravelly alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 1,800 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil is pale brown silt loam about 11 inches thick. The upper part of the substratum is pale brown gravelly silt loam about 10 inches thick, and the

lower part to a depth of 60 inches or more is pale brown and light gray very cobbly loam.

Included in this unit are areas of Ritzville and Willis soils.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for homesites is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be avoided by installing absorption lines on the contour.

This map unit is in capability subclass IIIe, nonirrigated.

108-Ritzville Variant cobbly silt loam, 5 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in loess overlying cobbly alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 1,800 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is brown cobbly silt loam about 7 inches thick. The subsoil is pale brown cobbly silt loam about 11 inches thick. The upper part of the substratum is pale brown gravelly silt loam about 10 inches thick, and the lower part to a depth of 60 inches or more is pale brown and light gray very cobbly loam.

Included in this unit are areas of Ritzville, Willis, and Kiona soils.

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

This unit is used as rangeland, wildlife habitat, and homesites.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Removal of stones might be necessary. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for homesites is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour or across the slope.

This map unit is in capability subclass IVe, nonirrigated.

109-Rock Creek very stony silt loam, 0 to 30 percent slopes. This shallow, well drained soil is on plateaus and ridgetops. It formed in loess and in residuum derived from basalt. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 3,200 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 170 days.

Typically, the surface layer is grayish brown very stony silt loam about 2 inches thick. The subsoil is brown very cobbly clay about 8 inches thick. Basalt is at a depth of about 10 inches. Depth to basalt ranges from 8 to 15 inches. In some areas the surface layer is stony.

Included in this unit are areas of McDaniel, Gorst, Clint, Taneum, and Simcoe soils and areas of Rock outcrop.

Permeability of this Rock Creek soil is moderately slow. Available water capacity is low. Effective rooting depth is 8 to 15 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland, wildlife habitat, and homesites.

The potential native vegetation is mainly Sandberg bluegrass, stiff sagebrush, and eriogonum. The main limitations for the production of forage are depth to rock and low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases. Areas that are heavily infested with undesirable vegetation can be improved by chemical treatment.

This unit is poorly suited to homesite development. The main limitations are shallow depth to bedrock, large stones, and steepness of slope. Bedrock hinders excavation. Removal of the large stones is needed for best results when landscaping, particularly in areas used for lawns.

The main limitations for septic tank absorption fields are shallow depth to bedrock, steepness of slope, and large stones. The shallow depth to bedrock limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Absorption lines should be placed on the contour or across the slope. The large stones can interfere with the location of these lines.

This map unit is in capability subclass VIIs, nonirrigated.

110-Rock Creek-Clint-Simcoe complex, 0 to 45 percent slopes. This map unit is on uplands. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,000 to 3,300 feet. The average annual precipitation is 10 to 18 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 120 to 135 days.

This unit is about 40 percent Rock Creek very stony silt loam, about 20 percent Clint very stony loam, and about 20 percent Simcoe silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Harwood soils that have slopes of less than 25 percent. Also included are areas of McDaniel and Taneum soils. Included areas make up about 20 percent of the total acreage.

The Rock Creek soil is very shallow and shallow and is well drained. It formed in loess and in residuum derived from basalt. Typically, the surface layer is grayish brown very stony silt loam about 2 inches thick. The subsoil is brown very cobbly clay about 8 inches thick. Basalt is at a depth of about 10 inches. Depth to bedrock ranges from 8 to 15 inches. In some areas the surface layer is stony.

Permeability of the Rock Creek soil is moderately slow. Available water capacity is low. Effective rooting depth is 8 to 15 inches. Runoff is rapid, and the hazard of water erosion is high.

The Clint soil is moderately deep and well drained. It formed in loess and in residuum derived from basalt. Typically, the upper part of the surface layer is reddish brown very stony loam about 6 inches thick, and the lower part is reddish brown gravelly loam about 4 inches thick. The subsoil is reddish brown very gravelly loam about 9 inches thick. The substratum is dark brown extremely gravelly loam about 9 inches thick. Fractured basalt is at a depth of about 28 inches. Depth to basalt ranges from 20 to 40 inches. In some areas the surface layer is stony.

Permeability of the Clint soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

The Simcoe soil is moderately deep and well drained. It formed in loess and in residuum derived from basalt. Typically, the surface layer is brown silt loam about 3 inches thick. The subsoil is brown silt loam about 24 inches thick. Basalt is at a depth of about 27 inches. Depth to basalt ranges from 20 to 40 inches.

Permeability of the Simcoe soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation of the Rock Creek soil is mainly stiff sagebrush, Sandberg bluegrass, and eriogonum. If the range is overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases.

The potential native vegetation of the Clint soil is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

The potential native vegetation of the Simcoe soil is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases.

The main limitations for the production of forage is the very stony surface layer of the Rock Creek and Clint soils. Areas of the Clint and Simcoe soils that are heavily infested with undesirable vegetation can be improved with such methods as chaining, chemical treatment, and prescribed burning. Care should be taken during brush control not to disturb the very shallow Rock Creek soil.

Range seeding on the Rock Creek soil is not feasible because of the very shallow and shallow depth to rock and low available water capacity. Seeding is difficult because of the stoniness of the Clint soil and the predominance of the Rock Creek soil between mounds of the Clint and Simcoe soils. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

111-Roza clay loam, 5 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from fine-textured sediment. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air tpmnnrptllro is nhniit rl rlenrpcc F nnri tha frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown clay loam about 2 inches thick. The upper part of the subsoil is grayish brown clay loam about 9 inches thick, and the lower part is light brownish gray silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is light brownish gray, pale brown, and light gray silty clay, silty clay loam, and clay loam. Vertical cracks 1/2- to 1-inch wide extend from the surface to a depth of about 19 inches. In some areas the soil is underlain by sandstone, and in some areas the soil has an intermittent hardpan.

Included in this unit are areas of Selah, Cowiche, and Cleman soils. Included areas make up about 25 percent of the total acreage.

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

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the slow permeability and steepness of slope. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. As the moisture content of the soil increases, the clay in this soil expands and the water infiltration rate is reduced. Irrigation water, therefore, should be applied at a slow rate over a long period of time to insure that the root zone is properly wetted. This also helps to control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

When the soil in this unit is excessively moist, operation of equipment increases the possibility of soil compaction, development of a plowpan, and formation of large clods at the surface. If the soil is compacted, it can be chiseled or subsoiled when dry. Seedbed preparation and seeding should be-done when the soil is dry. Applications of irrigation water should follow if needed.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Cover crops should be grown in orchards and vineyards to reduce erosion.

This unit is poorly suited to homesite development. The main limitation is shrink-swell potential, which can damage footings and foundations. Properly designing foundations and footings and diverting runoff away from buildings. help to prevent structural damage. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation. This map unit is in capability subclass IIIe, irrigated.

112-Roza clay loam, 8 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from fine-textured sediment. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is about 135 to 150 days.

Typically, the surface layer is grayish brown clay loam about 2 inches thick. The upper part of the subsoil is grayish brown clay loam about 9 inches thick, and the lower part is light brownish gray silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is light brownish gray, pale brown, and light gray silty clay, silty clay loam, and clay loam. Vertical cracks 1/2- to 1-inch wide extend from the surface to a depth of 19 inches. In some areas the soil is underlain by sandstone, and in some areas the soil has an intermittent hardpan.

Included in this unit are areas of Selah, Cowiche, and Cleman soils and areas of Roza soils that have slopes of less than 8 percent. Included areas make up about 25 percent of the total acreage.

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

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and slow permeability. Sprinkler and drip

irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. As the moisture content of the soil increases, the clay in this soil expands and the water infiltration rate is reduced. Irrigation water, therefore, should be applied at a slow rate over a long period of time to insure that the root zone is properly wetted. This also helps to control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

The soil in this unit should be cultivated when dry to reduce the possibility of soil compaction, development of a plowpan, and formation of large clods at the surface. If the soil is compacted, it can be chiseled or subsoiled when dry. Seedbed preparation and seeding should be done when the soil is dry. Applications of irrigation water should follow if needed.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Cover crops can be grown in orchards and vineyards to reduce erosion.

The potential native vegetation is mainly bluebunch wheatgrass, Cusick bluegrass, and spiny hopsage. The unit has few limitations for the production of forage. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rubber rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded just before the rains in fall using a drill. Because of the possibility of soil compaction and formation of large clods at the surface, the soil in this unit should be tilled when dry. Seedbed preparation and seeding can be done when the soil is dry. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is shrink-swell potential, which can damage footings or foundations. Properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is slow permeability. Use of sandy backfill for the trench and long absorption lines help to compensate for this limitation. Slope can cause lateral seepage and surfacing of the effluent in downslope areas. Absorption lines should be placed on the contour or across the slope.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

113-Roza clay loam, 15 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from fine-textured sediment. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 2,400 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown clay loam about 2 inches thick. The upper part of the subsoil is grayish brown clay loam about 9 inches thick, and the lower part is light brownish gray silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is light brownish gray, pale brown, and light gray silty clay, silty clay loam, and clay loam. Vertical cracks 1/2 to 1- wide extend from the surface to a depth of about 19 inches. In some areas the soil is cobbly throughout, in some areas the soil is underlain by sandstone, and in some areas the soil has an intermittent hardpan.

Included in this unit are areas of Selah, Cowiche, and Cleman soils. Included areas make up about 25 percent of the total acreage.

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

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crop is tree fruit. A cover crop is grown in orchards. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and slow permeability. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. As the moisture content of the soil increases, the clay in this soil expands and the water infiltration rate is reduced. Irrigation water, therefore, should be applied at a slow rate over a long period of time to insure that the root zone is properly wetted. This also helps to control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

When moist, the soil in this unit should not be cultivated because of the possibility of soil compaction, development of a plowpan, formation of large clods at the surface, and an extremely slippery soil condition. Where the soil is compacted, it can be chiseled or subsoiled when dry. Seedbed preparation and seeding

should be done when the soil is dry. Applications of irrigation water should follow if needed.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Cover crops can be grown in orchards and vineyards to reduce erosion.

The potential native vegetation is mainly bluebunch wheatgrass, Cusick bluegrass, and spiny hopsage. This unit has few limitations for the production of forage. If the range is overgrazed, the proportion of undesirable forage plants such as big sagebrush and rubber rabbitbrush increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. When moist, the soil in this unit should not be tilled because of the possibility of soil compaction and formation of large clods at the surface. Seedbed preparation and seeding should be done when the soil is dry. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are shrink-swell potential and steepness of slope. Shrinking and swelling of the soil in this unit can damage footings and foundations. Properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are steepness of slope and slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for the slow permeability. Slope can cause lateral seepage and surfacing of the effluent in downslope areas.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

114-Roza clay loam, 30 to 60 percent slopes. This very deep, well drained soil is on uplands. It formed in fine-textured sediment. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,300 to 2,400 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown clay loam about 2 inches thick. The upper part of the subsoil is grayish brown clay loam about 9 inches thick, and the lower part is light brownish gray silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is light brownish gray silty clay and silty clay loam. Vertical cracks 1 /2- to 1 -inch wide extend from the surface to a depth of about 19 inches. In some areas the soil is cobbly throughout, in some areas the soil is underlain by sandstone at a depth of 40 to 60 inches, and in some areas the soil has an intermittent hardpan.

Included in this unit are areas of Taneum soils, areas of Roza soils that have slopes of less than 30 percent, and areas of eroded soils.

Permeability of this Roza soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very rapid, and the hazard of water erosion is very high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass, Cusick bluegrass, and spiny hopsage. The main limitation for the production of forage is steepness of slope, which limits access and promotes overgrazing of the less sloping areas. The distribution of grazing in the steeply sloping areas of this unit can be improved by proper location of salt licks, stock watering facilities, and management fences.

If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rubber rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved with such methods as chemical treatment and prescribed burning. Aerial range seeding is a suitable practice if the range vegetation is in poor condition. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIe, nonirrigated.

115-Rubble land-Rock outcrop association. This map unit is in canyons and on steep mountainsides and escarpments. The native vegetation is scattered grasses and shrubs. Elevation is 2,400 to 7,000 feet. The average annual precipitation is 18 to 50 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 95 to 130 days.

This unit is about 70 percent Rubble land and 15 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 10 percent Sapkin and Bocker soils and about 5 percent Jumpe, Sutkin, and Naxing soils. Also included, on south-facing mountainsides between Darland Mountain and Klickitat Meadows, are areas that are about 70 percent Rock outcrop.

Rubble land consists of areas of cobbles and boulders on mountain toe slopes and areas of stone strips on steep mountainsides. It commonly is below areas of Rock outcrop and is mainly free of vegetation.

Rock outcrop is areas of exposed basalt.

This unit is used for wildlife habitat.

Most areas of the unit support mosses and lichens. Grazing is limited by low production and by the difficulty of animal movement. Production of timber is very limited.

Timber harvesting is restricted by stones and cobbles. Rubble land is a good source of material for road ballast.

This map unit is in capability subclass VIIIs, nonirrigated.

116-Sapkin very stony loam, 10 to 45 percent slopes. This moderately deep, well drained soil is on uplands and mountainsides. It formed in colluvium and residuum that are derived from basalt and contain small amounts of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 3,200 to 5,000 feet. The average annual precipitation is 18 to 35 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 95 to 130 days.

Typically, the upper part of the surface layer is dark grayish brown very stony loam about 7 inches thick, and the lower part is brown loam about 8 inches thick. The upper part of the subsoil is brown cobbly loam about 12 inches thick, and the lower part is brown very cobbly loam and extremely cobbly clay loam about 8 inches thick. Basalt is at a depth of about 35 inches. Depth to basalt ranges from 20 to 40 inches.

Included in this unit are areas of Bocker, Jumpe, and Sutkin soils; areas of Rock outcrop and Rubble land; and small convex areas of Sapkin soils that have slopes of 45 to 75 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly Idaho fescue, bluebunch wheatgrass, buckwheat, and threetip sagebrush. The production of forage is limited by the very stony surface layer. If the range is overgrazed, the proportion of preferred forage plants such as Idaho fescue and bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as threetip sagebrush and cheatgrass increases.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill.

This unit is limited for livestock watering ponds and other water impoundments because of moderate depth to bedrock. Water tanks, springs, wells, and pipelines are more suitable for providing stock water.

This map unit is in capability subclass VIIs, nonirrigated.

117-Sapkin very stony loam, 45 to 75 percent slopes. This moderately deep, well drained soil is on uplands and mountainsides. It formed in colluvium and residuum that are derived dominantly from basalt and contain small amounts of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 3,200 to 5,000 feet. The average annual precipitation is 18 to 35 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 95 to 130 days.

Typically, the upper part of the surface layer is dark grayish brown very stony loam about 7 inches thick. The lower part is brown loam about 8 inches thick. The upper part of the subsoil is brown cobbly loam about 12 inches thick, and the lower part is brown very cobbly loam and extremely cobbly clay loam about 8 inches thick. Basalt is at a depth of about 35 inches. Depth to basalt ranges from 20 to 40 inches.

Included in this unit are areas of Jumpe, Sutkin, and Bocker soils; areas of Rock outcrop and Rubble land; and small concave areas of Sapkin soils, on toe slopes and in convex areas on ridgetops, that have slopes of 10 to 45 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Sapkin soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly Idaho fescue, bluebunch wheatgrass, and threetip sagebrush. The main limitation for the production of forage is the presence of large stones. If the range is overgrazed, the proportion of preferred forage plants such as Idaho fescue and bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as threetip sagebrush and cheatgrass increases.

Steepness of slope promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water tanks, and fences promote more uniform distribution of grazing. Brush control is largely limited to aerial application of chemicals or to prescribed burning because of steepness of slope and stoniness. Seeding is hindered by stones on the surface and steepness of slope. Adapted grasses and legumes should be seeded.

This unit is limited for livestock watering ponds and other water impoundments because of moderate depth to bedrock. Water tanks, springs, wells, and pipelines are more effective means for providing stock water.

This map unit is in capability subclass VIIs, nonirrigated.

118-Sapkin-Rubble land complex, 30 to 75 percent slopes. This map unit is on mountainsides. Slope is dominantly about 45 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,800 to 5,600 feet. The average annual precipitation is 18 to 35 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 95 to 130 days.

This unit is about 60 percent Sapkin very stony loam and about 30 percent Rubble land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Sutkin and Bocker soils and areas of Rock outcrop. Included areas make up about 10 percent of the total acreage.

The Sapkin soil is moderately deep and well drained. It formed in residuum and colluvium derived dominantly from basalt and containing small amounts of loess. Typically, the upper part of the surface layer is dark grayish brown very stony loam about 7 inches thick. The lower part is brown loam about 8 inches thick. The upper part of the subsoil is brown cobbly loam about 12 inches thick, and the lower part is brown very cobbly loam and extremely cobbly clay loam about 8 inches thick. Basalt is at a depth of about 35 inches. Depth to basalt ranges from 20 to 40 inches. In some areas the subsoil is clay loam, and in some areas bedrock is at a depth of more than 40 inches.

Permeability of the Sapkin soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

Rubble land is areas of cobbles, stones, and boulders. It is mainly free of vegetation.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly Idaho fescue, bluebunch wheatgrass, and threetip sagebrush on the Sapkin soil. The main limitations for the production of forage are the presence of large stones and steepness of slope, which promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water tanks, and fences promote more uniform distribution of grazing. If the range is overgrazed, the proportion of preferred forage plants such as Idaho fescue and bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as threetip sagebrush and cheatgrass increases.

Areas that are heavily infested with undesirable vegetation can be improved with such methods as chemical treatment and prescribed burning. Plant control is mainly limited to chemical application by air or to prescribed burning because of steepness of slope and stoniness. This unit should be seeded in fall. Adapted grasses and legumes should be seeded.

This unit is limited for livestock watering ponds and other water impoundments because of moderate depth to basalt. Water tanks, springs, wells, and pipelines are more effective means for providing stock water.

This map unit is in capability subclass VIIs, nonirrigated.

119-Saydab cobbly loam, 0 to 5 percent slopes. This moderately deep, moderately well drained soil is on smooth mountaintops and broad ridgetops. It formed in colluvium and residuum derived from basalt and containing small amounts of loess. The native vegetation is mainly conifers and grasses. Elevation is 5,500 to 7,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, is 80 to 110 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 inch thick. The upper part of the surface layer is dark brown cobbly loam about 5 inches thick, and the lower part is dark brown loam about 6 inches thick. The subsoil is yellowish brown very cobbly loam about 16 inches thick. Basalt is at a depth of about 27 inches. Depth to basalt ranges from 25 to 30 inches.

Included in this unit are areas of Naxing and Darland soils, areas of Saydab soils that have slopes of more than 15 percent, and areas of soils that have basalt at a depth of 10 to 20 inches. Included areas make up about 10 percent of the total acreage.

Permeability of this Saydab soil is moderate. Available water capacity is low. Effective rooting depth is 25 to 30 inches. Runoff is slow, and hazard of water erosion is slight.

This unit is used as grazable woodland and for wildlife habitat.

Subalpine fir and western larch are the main woodland species on this unit. Among the trees of limited extent are whitebark pine, lodgepole pine, and Engelmann spruce. On the basis of a 50-year site curve, the mean site index is 49 for western larch. Yield tables for normal, even-aged, unmanaged stands of western larch indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 70 years of age is 61 cubic feet per acre. The mean annual increment for trees 7.6 inches in diameter and larger at 80 years of age is 30 cubic feet per acre. On the basis of a 100-year site curve, the mean site index is 87 for lodgepole pine and 74 for subalpine fir. Yield tables for normal, even-aged, unmanaged stands of lodgepole pine at 100 years of age indicate that the mean annual increment at culmination is about 100 cubic feet per acre. However, the typical basal area of stands on this unit is about 60 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is snowpack, which hinders the use of equipment and limits access in winter. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. If seed trees are present, natural reforestation of cutover areas by subalpine fir occurs periodically. Low soil temperatures, heavy snowpack, and the short growing season limit the even distribution of natural reforestation, especially on north-facing

slopes. Because the rooting depth is restricted by underlying bedrock, trees are occasionally subject to windthrow.

The common forest understory plants are elk sedge, pinegrass, vetch, yarrow, sagebrush, currant, and dwarf huckleberry. The crown density in the areas where the woodland site index was measured is 30 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This unit is limited for livestock watering ponds and other water impoundments because of moderate depth to bedrock. Spring developments, wells, or pipelines can be used to provide stock water.

This map unit is in capability subclass VIe, nonirrigated.

120-Scoon silt loam. 2 to 5 percent slopes. This well drained soil in on uplands. It is shallow over a lime- and silica-cemented hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is light brownish gray silt loam about 6 inches thick. The subsoil is light brownish gray silt loam about 4 inches thick. The substratum is light brownish gray gravelly silt loam about 6 inches thick. A hardpan is at a depth of about 16 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt, but in some areas it is underlain by sand and gravel. In some areas the surface layer is very fine sandy loam.

Included in this unit are small areas of Shano, Burke, Roza, and Starbuck soils, areas of Rock outcrop, and areas of Scoon soils that have slopes of less than 2 percent.

Permeability of this Scoon soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, mint, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of irrigation water, reduces runoff, and minimizes the risk of erosion. Shallow depth to the pan and steepness of slope make water management extremely important. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops and growing mint in meadows rather than in rows reduce water erosion. Perennial cover crops reduce erosion in orchards.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of low available water capacity. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites is the shallow depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the shallow depth to the pan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclasses IVe, irrigated, and VIe, nonirrigated.

121-Scoon silt loam, 5 to 8 percent slopes. This well drained soil is on uplands. It is shallow over a lime- and silica-cemented hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is light brownish gray silt loam about 6 inches thick. The subsoil is light brownish gray silt loam about 4 inches thick. The substratum is light brownish gray gravelly silt loam about 6 inches thick. A hardpan is at a depth of about 16 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt, but in some areas it is underlain by sand and gravel. In some areas the surface layer is very fine sandy loam.

Included in this unit are small areas of Shano, Burke, Roza, and Starbuck soils, areas of Rock outcrop, and areas of Scoon soils that have slopes of less than 5 percent.

Permeability of this Scoon soil is moderate above the hardpan and very slow through it. Available water

capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, mint, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of irrigation system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Shallow soil depth and steepness of slope make water management extremely important. To avoid loss of water and leaching of plant nutrients from over irrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops and growing mint in meadows rather than in rows reduce water erosion. Perennial cover crops are needed in orchards to reduce erosion.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition, but it is limited by low available water capacity. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites is depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the shallow depth to the hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclasses IVe, irrigated, and VIe, nonirrigated.

122-Scoon silt loam, 8 to 15 percent slopes. This well drained soil is on uplands. It is shallow over a lime- and silica-cemented hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is light brownish gray silt loam about 6 inches thick. The subsoil is light brownish gray silt loam about 4 inches thick. The substratum is light brownish gray gravelly silt loam about 6 inches thick. A hardpan is at a depth of about 16 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt, but in some areas it is underlain by sand and gravel. In some areas the surface layer is very fine sandy loam.

Included in this unit are small areas of Shano, Roza, and Starbuck soils, areas of Rock outcrop, and areas of Scoon soils that have slopes of less than 8 percent or more than 15 percent.

Permeability of this Scoon soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of irrigation water, reduces runoff, and minimizes the risk of erosion. Shallow soil depth and steepness of slope make water management extremely important. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops reduce erosion in orchards.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition, but it is difficult because of the low available water capacity. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites is shallow depth to the hardpan, which hinders excavation. Dustiness can be a

problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the shallow depth to the hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclasses IVe, irrigated, and Vle, nonirrigated.

123-Scoon silt loam, 15 to 30 percent slopes. This well drained soil is on uplands. It is shallow over a lime- and silica-cemented hardpan. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is light brownish gray silt loam about 6 inches thick. The subsoil is light brownish gray silt loam about 4 inches thick. The substratum is light brownish gray gravelly silt loam about 6 inches thick. A hardpan is at a depth of about 16 inches. Depth to the hardpan ranges from 10 to 20 inches. The hardpan commonly is underlain by basalt, but in some areas it is underlain by sand and gravel. In some areas the surface layer is very fine sandy loam.

Included in this unit are areas of Shano, Roza, and Starbuck soils, areas of Rock outcrop, and areas of Scoon soils that have slopes of less than 15 percent.

Permeability of this Scoon soil is moderate above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated hay, pasture, and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grasses and legumes.

The main limitations for irrigated orchard, hay, and pasture crops are the shallow depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops reduce erosion in orchards.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition; however, establishment of seedlings is difficult because of the low available water capacity. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are the shallow depth to the hardpan and steepness of slope. The pan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the main limitations are the shallow depth to the hardpan and steepness of slope. The pan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Absorption lines should be installed on the contour.

This map unit is in capability subclass Vle, irrigated and nonirrigated.

124-Scooteney silt loam, 0 to 2 percent slopes. This very deep, well drained soil is on terraces. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is 51 degrees F, and the average frost-free season is 135 to 170 days.

Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is pale brown silt loam about 16 inches thick. The upper part of the substratum is light brownish gray gravelly fine sandy loam about 11 inches thick, and the lower part to a depth of 60 inches or more is light brownish gray very gravelly sandy loam. In some areas the surface layer is sandy loam.

Included in this unit are small areas of Starbuck and Esquatzel soils.

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

This unit is used for irrigated crops, wildlife habitat, and homesites. The main irrigated crops are corn, grapes, hops, and peas. Grasses and legumes are grown for hay, pasture, and seed.

This unit has few limitations for irrigated crops. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation

permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is well suited to homesite development. Dustiness may be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclass IIs, irrigated.

125-Scooteney silt loam, 2 to 5 percent slopes. This very deep, well drained soil is on terraces. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is 51 degrees F, and the average frost-free season is 135 to 170 days.

Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is pale brown silt loam about 16 inches thick. The upper part of the substratum is light brownish gray gravelly fine sandy loam about 11 inches thick, and the lower part to a depth of 60 inches or more is light brownish gray very gravelly sandy loam. In some areas the surface layer is sandy loam, and in some areas the subsoil and substratum are gravelly.

Included in this unit are small areas of Finley, Scoon, Burke, and Esquatzel soils and Scooteney soils that have slopes of more than 5 percent.

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

This unit is used for irrigated and nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, hops, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, and shaping and seeding waterways to perennial grass. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Thurber needlegrass, and big sagebrush. If the range is overgrazed, the proportion of less preferred forage plants such as balsamroot and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclass IIe, irrigated and IVe, nonirrigated.

126-Scooteney silt loam, 5 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is 51 degrees F, and the average frost-free season is 135 to 170 days.

Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is pale brown silt loam about 16 inches thick. The upper part of the substratum is light brownish gray gravelly fine sandy loam about 11 inches thick, and the lower part to a depth of 60 inches or more is light brownish gray very gravelly sandy loam. In some areas the surface layer is sandy loam, and in some areas the subsoil and substratum are gravelly.

Included in this unit are small areas of Finley, Scoon, and Burke soils and Scooteney soils that have slopes of more than 15 percent.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, shaping waterways and seeding them to perennial grass, using terraces, and stripcropping. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Thurber needlegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as balsamroot and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for homesites is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, slope can cause lateral seepage of effluent and subsequent surfacing in downslope areas. Absorption lines should be installed on the contour or across the slope.

This map unit is in capability subclass IVe, nonirrigated.

127-Scooteney cobbly silt loam, 0 to 5 percent slopes. This very deep, well drained soil is on terraces. It formed in alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is 51 degrees F, and the average frost-free season is 135 to 170 days.

Typically, the surface layer is brown cobbly silt loam about 6 inches thick. The subsoil is pale brown silt loam about 16 inches thick. The upper part of the substratum is light brownish gray gravelly fine sandy loam about 11 inches thick, and the lower part to a depth of 60 inches or more is light brownish gray very gravelly sandy loam. In some areas the surface layer is sandy loam, silt loam, or gravelly silt loam.

Included in this unit are areas of Finley and Esquatzel soils.

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

This unit is used as rangeland, wildlife habitat, and homesites.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, and Thurber needlegrass. The main limitation for the production of forage is low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as balsamroot and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Seedbed preparation can be difficult because of cobbles. Removal of the cobbles might be necessary. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclass VIe, nonirrigated.

128-Selah silt loam, 2 to 5 percent slopes. This well drained soil is on high dissected terraces. It is moderately deep over a lime- and silica-cemented

hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 180 days.

Typically, the surface layer is grayish brown and brown silt loam about 7 inches thick. The subsoil is pale brown, light brownish gray, and brown silt loam and silty clay loam about 27 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the hardpan is underlain by basalt, and in some areas it is underlain by sand and gravel.

Included in this unit are small areas of Willis, Ritzville, and Roza soils.

Permeability of this Selah soil is moderately slow above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan and the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and reduces erosion. If surface irrigation is used, erosion can be minimized by keeping runs short. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Using a cropping system that includes close-growing, high-residue crops in the rotation and growing mint in meadows rather than in rows reduce water erosion. Annual or perennial cover crops reduce erosion in orchards and vineyards. A plowpan develops in the soil in this unit; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitation is moderate depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are the moderate depth to the hardpan and slow permeability. Moderate depth to the hardpan limits the capacity of the absorption fields. Use of sandy backfill for the trench and long absorption lines helps to compensate for both of these limitations.

The map unit is in capability subclass IIe, irrigated.

129-Selah silt loam, 5 to 8 percent slopes. This well drained soil is on high dissected terraces. It is moderately deep over a lime- and silica-cemented hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 180 days.

Typically, the surface layer is grayish brown and brown silt loam about 7 inches thick. The subsoil is pale brown, light brownish gray, and brown silt loam and silty clay loam about 27 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the hardpan is underlain by basalt, and in some areas it is underlain by sand and gravel.

Included in this unit are small areas of Willis, Ritzville, and Roza soils.

Permeability of this Selah soil is moderately slow above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Growing cover crops reduces erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitation is moderate depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan and moderately slow permeability. Depth to the hardpan limits the capacity of

the absorption fields. Use of sandy backfill for the trench and long absorption lines helps to compensate for both of these limitations.

This map unit is in capability subclass IIIe, irrigated.

130-Selah silt loam, 8 to 15 percent slopes. This well drained soil is on high dissected terraces. It is moderately deep over a lime- and silica-cemented hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 180 days.

Typically, the surface layer is grayish brown and brown silt loam about 7 inches thick. The subsoil is pale brown, light brownish gray, and brown silt loam and silty clay loam about 27 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the hardpan is underlain by basalt, and in some areas it is underlain by sand and gravel.

Included in this unit are small areas of Willis, Ritzville, and Roza soils.

Permeability of this Selah soil is moderately slow above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grasses, legumes, and tree fruit. A cover crop is grown in orchards.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Growing annual or perennial cover crops reduces erosion in orchards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, big sagebrush, and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is moderate depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are depth to the hardpan and the moderately slow permeability. Depth to the hardpan limits the capacity of the absorption fields. Use of sandy backfill for the trench and long absorption lines helps to compensate for both of these limitations. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclasses IVe, irrigated, and IIIe, nonirrigated.

131-Selah silt loam, 15 to 30 percent slopes. This well drained soil is on high dissected terraces. It is moderately deep over a lime- and silica-cemented hardpan. It formed in loess and old alluvium. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 180 days.

Typically, the surface layer is grayish brown and brown silt loam about 7 inches thick. The subsoil is pale brown, light brownish gray, and brown silt loam and silty clay loam about 27 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the hardpan is underlain by basalt, and in some areas it is underlain by sand and gravel.

Included in this unit are small areas of Willis, Ritzville, and Roza soils.

Permeability of the Selah soil is moderately slow above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain; grasses and legumes for hay, pasture, and seed; and tree fruit. A cover crop is grown in orchards.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops are needed in orchards and vineyards to reduce erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, big sagebrush, and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are moderate depth to the hardpan and steepness of slope. The hardpan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are moderate depth to the hardpan, steepness of slope, and moderately slow permeability. The moderate depth to the hardpan limits the capacity of the absorption fields. Slope can cause lateral seepage and surfacing of the effluent in downslope areas. Use of sandy backfill for the trench and long absorption lines helps to compensate for the moderate depth to the hardpan and the moderately slow permeability.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

132-Shano silt loam, 2 to 5 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

Typically, the surface layer is brown silt loam about 4 inches thick. The subsoil is pale brown silt loam about 26 inches thick. The substratum to a depth of 60 inches or more is pale brown silt loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Warden, Burke, and Esquatzel soils and areas of Shano soils that have slopes of less than 2 percent.

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

This unit is used for irrigated and nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler and drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rates should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes

close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows greatly reduces erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early and stubble mulching. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in a few places to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclass IIe, irrigated, and IVe, nonirrigated.

133-Shano silt loam, 5 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

Typically, the surface layer is brown silt loam about 4 inches thick. The subsoil is pale brown silt loam about 26 inches thick. The substratum to a depth of 60 inches or more is pale brown silt loam. In some areas the surface layer is loam.

Included in this unit are small areas of Warden and Burke soils and areas of Shano soils that have slopes of more than 8 percent.

Permeability of this Shano soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated crops and as rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, peas, and mint. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. It has few limitations. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclasses IIIe, irrigated, and IVe, nonirrigated.

134-Shano silt loam, 8 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs,

and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

Typically, the surface layer is brown silt loam about 4 inches thick. The subsoil is pale brown silt loam about 26 inches thick. The substratum to a depth of 60 inches or more is pale brown silt loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Warden, Scooteney, and Burke soils and Shano soils that have slopes of less than 8 percent.

Permeability of this Shano soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated and nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and grapes. Grasses and legumes are grown for hay, pasture, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Annual or perennial cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for homesites is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If the unit is used for septic tank absorption fields, steepness of slope can cause lateral seepage and surfacing of effluent in downslope areas. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

135-Shano silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

Typically, the surface layer is brown silt loam about 4 inches thick. The subsoil is pale brown silt loam about 26 inches thick. The substratum to a depth of 60 inches or more is pale brown silt loam.

Included in this unit are areas of Warden and Burke soils.

Permeability of this Shano soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range

vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, steepness of slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass IVe, nonirrigated.

136-Simcoe silt loam, 5 to 15 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess and in residuum derived from basalt and a small amount of volcanic ash. Slope is dominantly about 10 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,300 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 170 days.

Typically, the surface layer is brown silt loam about 3 inches thick. The upper part of the subsoil is brown silt loam about 11 inches thick, and the lower part is brown silt loam about 13 inches thick. Basalt is at a depth of about 27 inches. Depth to basalt ranges from 20 to 40 inches. In some areas the surface layer is loam.

Included in this unit are areas of Harwood, Rock Creek, and Selah soils, areas of Rock outcrop, and areas of Simcoe soils that have slopes of more than 15 percent.

Permeability of this Simcoe soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope, depth to rock, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Annual or perennial cover crops reduce erosion in orchards.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is moderate depth to rock, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are moderate depth to rock and moderately slow permeability. The moderate depth to rock limits the capacity of the absorption fields. Use of sandy backfill for the trench and long absorption lines helps to compensate for the moderately slow permeability. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Absorption lines should be placed on the contour or across the slope.

This map unit is in capability subclasses IVe, irrigated, and IIIe, nonirrigated.

137-Simcoe silt loam, 15 to 30 percent slopes. This moderately deep, well drained soil is on uplands. It formed in loess and in residuum derived from basalt and contains a small amount of volcanic ash. Slope is dominantly about 20 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,200 to 2,300 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 170 days.

Typically, the surface layer is brown silt loam about 3 inches thick. The subsoil is brown silt loam about 24 inches thick. Basalt is at a depth of about 27 inches. Depth to basalt ranges from 20 to 40 inches. In some areas the surface layer is loam, and in some areas the subsoil is gravelly.

Included in this unit are areas of Rock Creek and Selah soils, areas of Rock outcrop, and areas of Simcoe soils that have slopes of more than 30 percent.

Permeability of this Simcoe soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope, depth to rock, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Perennial cover crops reduce erosion in orchards and vineyards.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are moderate depth to rock and steepness of slope. The bedrock hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are moderate depth to rock, steepness of slope, and moderately slow permeability. The moderate depth to rock limits the capacity of the absorption fields. Use of sandy backfill for the trench and long absorption lines helps to compensate for the moderately slow permeability. Steepness of slope can cause lateral seepage and surfacing of the effluent in downslope areas.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

138-Sinloc fine sandy loam, 0 to 2 percent slopes. This very deep, artificially drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is dark grayish brown, strongly alkaline fine sandy loam about 3 inches thick. The subsoil is dark grayish brown, strongly alkaline silt loam about 12 inches thick. The upper part of the substratum is dark grayish brown, strongly alkaline and moderately alkaline, stratified silt loam and fine sandy loam about 30 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown, moderately alkaline loamy fine sand.

Included in this unit are areas of Warden, Hezel, Shano, Harwood, Burke, Outlook, and Wiehl soils and areas of Sinloc soils that have not been artificially drained. Included areas make up about 20 percent of the total acreage.

Permeability of this Sinloc soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 42 inches from May to October. Runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is high.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. In areas that are drained, leached of excessive salts, and irrigated, the main irrigated crops are asparagus, corn, grain, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are wetness and the hazard of soil blowing. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Proper timing of minimum tillage and return of crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. The soil in this unit should be protected with plant cover or residue in spring when the soil is most susceptible to soil blowing. Use of straw, manure, or other waste material as a mulch also reduces soil blowing. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan may develop in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Deep-rooted crops are suited to areas where a drainage system has been installed and is adequately maintained. If the drainage system is not maintained, the soil has a seasonal high water table and a high salt content during the irrigation season.

This unit is poorly suited to homesite development. The main limitation for building sites and septic tank absorption fields is wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around the footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. The plants used as ground cover should be adapted to the salt- and alkali-affected condition of the soil. The seasonal high water table increases the possibility of failure of septic tank absorption fields. It also increases the risk of contaminating water supplies as a result of seepage. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIw, irrigated.

139-Sinloc silt loam, 0 to 2 percent slopes. This very deep, artificially drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is dark grayish brown, strongly alkaline silt loam about 3 inches thick. The subsoil is dark grayish brown, strongly alkaline silt loam about 12 inches thick. The upper part of the substratum is dark grayish brown, stratified, strongly alkaline and moderately alkaline silt loam and very fine sandy loam about 30 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown, moderately alkaline loamy fine sand.

Included in this unit are small areas of Warden, Hezel, Shano, Harwood, Burke, Outlook, and Wiehl soils and areas of Sinloc soils that have not been artificially drained.

Permeability of this Sinloc soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 42 inches from May to October. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Where drained, leached of excessive salts, and irrigated, the main irrigated crops are asparagus, corn, grain, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is wetness. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, improve the water infiltration rate, and reduce erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in the soil in this unit; however, it can be broken by chiseling or subsoiling when the soil is dry. Deep-rooted crops are suited to areas where a drainage system has been installed and is adequately maintained. If the drainage system is not maintained, the soil has a seasonal high water table during the irrigation season and has a high content of salt.

This unit is poorly suited to homesite development. The main limitation for homesites and for septic tank absorption fields is wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. The plants used as ground cover should be adapted to saline conditions. The seasonal high water table increases the possibility of failure of septic tank absorption fields. It also increases the risk of contaminating water supplies as a result of seepage. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIw, irrigated.

140-Sinloc silt loam, 2 to 5 percent slopes. This very deep, artificially drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is dark grayish brown, strongly alkaline silt loam about 3 inches thick. The

subsoil is dark grayish brown, strongly alkaline silt loam about 12 inches thick. The upper part of the substratum is dark grayish brown, stratified, strongly alkaline and moderately alkaline silt loam and very fine sandy loam about 30 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown, moderately alkaline loamy fine sand.

Included in this unit are small areas of Warden, Hezel, Shano, Harwood, Burke, Outlook, and Wiehl soils, areas of Sinloc soils that have not been artificially drained, and areas of Sinloc soils that have slopes of more than 5 percent.

Permeability of this Sinloc soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 42 inches from May to October. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. In areas that have been drained, leached of excessive salts, and irrigated, the main irrigated crops are asparagus, corn, grain, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are wetness and the hazard of water erosion. Deep-rooted crops are suited to areas where a drainage system has been installed. If the drainage system is not maintained, this soil has a seasonal high water table during the irrigation season and has a high content of salt. If furrow and corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of a sprinkler irrigation system permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Tilling when the moisture content of the soil is optimal and returning crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows greatly reduces erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around the footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. The plants used as ground cover should be adapted to saline and alkaline conditions. The seasonal high water table increases the possibility of failure of septic tank absorption fields. It also increases the risk of contaminating water supplies as a result of seepage. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIw, irrigated.

141-Sinloc silt loam, 5 to 8 percent slopes. This very deep, artificially drained soil is on terraces. It formed in lacustrine sediment. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is dark grayish brown, strongly alkaline silt loam about 3 inches thick. The subsoil is dark grayish brown, strongly alkaline silt loam about 12 inches thick. The upper part of the substratum is dark grayish brown, stratified, strongly alkaline and moderately alkaline silt loam and very fine sandy loam about 30 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown, moderately alkaline loamy fine sand. The soil is strongly alkaline or moderately alkaline throughout.

Included in this unit are small areas of Warden, Hezel, Shano, Harwood, Burke, and Wiehl soils and areas of Sinloc soils that have not been artificially drained.

Permeability of this Sinloc soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 42 inches during May to October. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated crops, wildlife habitat, and homesites. In areas that have been drained, leached of excessive salts, and irrigated, the main irrigated crops are corn, grain, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are wetness, steepness of slope, and the hazard of water erosion. Deep-rooted crops are suited to areas where a drainage system has been installed and is adequately maintained. Dikes are effective in diverting floodwater. If drainage systems are not maintained, the soil in this unit has a seasonal high water table during the irrigation season and a high content of salt.

Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of irrigation system used depends on the kind of crop grown. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control erosion and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, improve the water infiltration rate, and reduce erosion. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is wetness. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around the footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. The plants used as ground cover should be adapted to saline conditions. The high water table increases the possibility of failure of septic tank absorption fields. It also increases the risk of contaminating water supplies as a result of seepage. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIw, irrigated.

142-Starbuck silt loam, 2 to 15 percent slopes. This shallow, well drained soil is on uplands. It formed in loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 2,000 feet. The average annual precipitation ranges from 6 to 11 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is pale brown silt loam and gravelly silt loam about 10 inches thick. Basalt is at a depth of about 16 inches. Depth to basalt ranges from 12 to 20 inches. In some areas the surface layer is stony.

Included in this unit are areas of Scoon, Harwood, Burke, and Wiehl soils, areas of Rock outcrop, and areas of Starbuck soils that have slopes of less than 2 percent or more than 15 percent.

Permeability of this Starbuck soil is moderate. Available water capacity is low. The effective rooting depth is 12 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crop is grain. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to rock, steepness of slope, and the hazard of water erosion. Sprinkler irrigation is suited to the soil in this unit. It permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue in the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill when the moisture content of the soil is optimum. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites is shallow depth to rock, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, shallow depth to bedrock limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclasses IVe, irrigated, and VIe, nonirrigated.

143-Starbuck-Rock outcrop complex, 0 to 45 percent slopes. This map unit is on uplands. Slope dominantly is about 25 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 2,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50

degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 50 percent Starbuck silt loam and about 25 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Kiona, Scoon, Bakeoven, Prosser, Ritzville, Harwood, Burke, Wiehl, and Shano soils. Also included are small areas of somewhat poorly drained soils in basins. Included areas make up about 25 percent of the total acreage.

The Starbuck soil is shallow and well drained. It formed in loess overlying basalt. Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is pale brown silt loam and gravelly silt loam about 10 inches thick. Basalt is at a depth of about 16 inches. Depth to basalt ranges from 12 to 20 inches.

Permeability of the Star buck Soil is moderate. Available water capacity is low. The effective rooting depth is 12 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

Rock outcrop is areas of exposed bedrock.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by low available water capacity and areas of Rock outcrop. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved with such methods as chemical treatment and prescribed burning.

Range seeding on the Starbuck soil is a suitable practice if the range vegetation is in poor condition, but it is difficult because of the areas of Rock outcrop. Most areas of the soil can be seeded with a drill. The unit should be seeded in fall. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

144-Starbuck-Rock outcrop complex, 45 to 60 percent slopes. This map unit is on uplands. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 2,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

This unit is about 45 percent Starbuck silt loam and about 35 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Kiona, Bakeoven, Ritzville, and Shano soils. Included areas make up about 20 percent of the total acreage.

The Starbuck soil is shallow and well drained. It formed in loess overlying basalt. Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is pale brown silt loam and gravelly silt loam about 10 inches thick. Basalt is at a depth of about 16 inches. Depth to basalt ranges from 12 to 20 inches.

Permeability of the Starbuck soil is moderate. Available water capacity is low. Effective rooting depth is 12 to 20 inches. Runoff is rapid, and the hazard of water erosion is high.

Rock outcrop is areas of exposed bedrock.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation of the Starbuck soil is mainly bluebunch wheatgrass and Sandberg bluegrass. The production of forage is limited by steepness of slope and areas of Rock outcrop. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Brush control is mainly limited to aerial application of chemicals or prescribed burning. Steepness of slope and the areas of Rock outcrop limit access by livestock and promote overgrazing of the less sloping areas. Proper placement of salt licks, stock water tanks, and fences promote more uniform distribution of grazing. Aerial seeding of the Starbuck soil may be desirable. Seedings generally are most successful in fall. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIs, nonirrigated.

145-Sutkin stony loam, 0 to 25 percent slopes. This very deep, well drained soil is on smooth mountaintops. It formed in colluvium and residuum derived dominantly from basalt and containing small amounts of loess. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,400 to 4,400 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1 /2 inch thick. The surface layer is dark brown stony loam about 10 inches thick. The subsoil is dark yellowish brown very cobbly loam and extremely cobbly loam about 28 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam. In some areas the subsoil is loam, gravelly loam, or very cobbly clay.

Included in this unit are areas of Sapkin and Bocker soils and areas of Sutkin soils that have slopes of 25 to 45 percent. Included areas make up about 10 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 67 for ponderosa pine and 81 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 52 cubic feet per acre for ponderosa pine at age 50 and 71 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre for ponderosa pine and 57 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 90 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs infrequently. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are pinegrass, elk sedge, yarrow, ceanothus, and Oregon-grape. The crown density in the areas where the woodland site index was measured is 30 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIs, nonirrigated.

146-Sutkin stony loam, 25 to 45 percent slopes. This very deep, well drained soil is on mountainsides. It formed in colluvium and residuum derived dominantly from basalt and small amounts of loess. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1/2 inch thick. The surface layer is dark brown stony loam about 10 inches thick. The subsoil is dark yellowish brown very cobbly loam and extremely cobbly loam about 28 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam. In some areas the subsoil is very cobbly clay.

Included in this unit are about 10 percent Sapkin soils, about 5 percent Bocker soils, areas of Rock outcrop and Rubble land, and areas of Sutkin soils that have slopes of less than 25 percent or more than 45 percent.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Among the trees of limited extent are western larch and Oregon white oak. On the basis of a 100-year site curve, the mean site index is 67 for ponderosa pine and 81 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 52 . cubic feet per acre for ponderosa pine at age 50 and 71 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 45 cubic feet per acre for ponderosa pine and 60 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 80 percent that of normal stands, and total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. Cable yarding systems are safer, and they disturb the soil less. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in included areas of Rock outcrop and Rubble land.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs periodically. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are pinegrass, elk sedge, bitterbrush, yarrow, Oregon-grape, common snowberry, and ceanothus. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

147-Sutkin stony loam, 45 to 65 percent slopes. This very deep, well drained soil is on mountainsides. It formed in colluvium and residuum derived dominantly from basalt and containing small amounts of loess. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 3,400 to 4,600 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1/2 inch thick. The surface layer is dark brown stony loam about 10 inches thick. The subsoil is dark yellowish brown very cobbly loam and extremely cobbly loam about 28 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

Included in the unit are areas of Sapkin soils, Rock outcrop, Rubble land, and Sutkin soils that have slopes of less than 45 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Sutkin soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Among the trees of limited extent are Oregon white oak, western larch, and grand fir. On the basis of a 100-year site curve, the mean site index is 67 for ponderosa pine and 81 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 52 cubic feet per acre for ponderosa pine at age 50 and 71 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre for ponderosa pine and 65 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer, and they disturb the soil less. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in included areas of Rock outcrop and Rubble land.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir occurs periodically. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, bitterbrush, common snowberry, and Oregon-grape. The crown density in the areas where the woodland site index was measured is 35 percent. This unit is well suited to browsing; however, steepness of slope limits access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful. Because of the steepness of slope, broadcast seeding should be used.

Seeding of adapted grazable plants following logging or burning reduces soil erosion, preserves water quality, and increases the production of understory. Seeding late in summer or in fall is most successful. The presence of logging debris and steepness of slope limit seeding.

This map unit is in capability subclass VIIs, nonirrigated.

148-Sutkin stony loam, 25 to 45 percent south slopes. This very deep, well drained soil is on mountainsides and in canyons. It formed in colluvium and residuum derived dominantly from basalt and small amounts of loess. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,800 to 4,000 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1/2 inch thick. The surface layer is dark brown stony loam about 10 inches thick. The subsoil is dark yellowish brown very cobbly loam and extremely cobbly loam about 28 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam. In some areas the subsoil is very cobbly clay, and in some small concave areas on terraces the subsoil is loam or gravelly loam.

Included in this unit are areas of Sapkin and Bocker soils, areas of Rubble land and Rock outcrop, small convex areas of soils that have slopes of more than 45 percent, and small concave areas of soils that have slopes of less than 25 percent. Included areas make up about 15 percent of the total acreage.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. Numerous patches of

Oregon white oak are also present. On the basis of a 100-year site curve, the mean site index is 49 for ponderosa pine and 65 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 37 cubic feet per acre for ponderosa pine at age 60 and 50 cubic feet per acre for Douglas-fir at age 50. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 20 cubic feet per acre for ponderosa pine and 40 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 75 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which makes the use of wheeled and tracked equipment difficult. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in included areas of Rubble land and Rock outcrop.

Seeding establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. The droughtiness of the soil increases seedling mortality.

The common forest understory plants are elk sedge, pinegrass, bitterbrush, yarrow, and Oregon-grape. The crown density in the areas where the woodland site index was measured is 20 percent. This unit is suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

149-Sutkin-Rock outcrop complex, 25 to 75 percent slopes. This map unit is on mountainsides. Slope is dominantly about 50 percent. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,800 to 4,000 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

This unit is about 55 percent Sutkin stony loam and about 25 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Sapkin soils and Rubble land and concave areas of soils that have slopes of less than 25 percent. Included areas make up about 20 percent of the total acreage.

The Sutkin soil is very deep and well drained. It formed in residuum and colluvium derived dominantly from basalt and containing small amounts of loess. Typically, the surface is covered with a mat of partially decomposed organic material about 1/2 inch thick. The surface layer is dark brown stony loam about 10 inches thick. The subsoil is dark yellowish brown very cobbly loam and extremely cobbly loam about 28 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

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

Rock outcrop is areas of exposed bedrock. It is on hilly to extremely steep mountainsides.

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on the Sutkin soil. On the basis of a 100-year site curve, the mean site index is 67 for ponderosa pine and 81 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 52 cubic feet per acre for ponderosa pine at age 50 and 71 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 40 cubic feet per acre for ponderosa pine and 65 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on the Sutkin soil is about 70 percent that of normal stands, and the total yield is correspondingly lower.

The main limitations for the harvesting of timber are steepness of slope and areas of Rock outcrop, which restrict the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer, and they disturb the soil less. Areas of Rock outcrop and Rubble land hinder cable yarding. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Avoiding areas of Rock outcrop commonly forces yarding and skidding paths to converge, which increases the potential for erosion and soil compaction.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes. The areas of Rock outcrop limit the even distribution of reforestation.

The common forest understory plants are elk sedge, pinegrass, bitterbrush, common snowberry, and Oregon-grape. The crown density in the areas where the woodland site index was measured is 30 percent. The

Sutkin soil is suited to grazing and browsing. Steepness of slope and the areas of Rock outcrop limit access by livestock and encourage overgrazing of the less sloping areas. The distribution of grazing in the steeply sloping areas of this soil can be improved by proper location of salt licks, stock watering facilities, and management fences. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

150-Sutkin Variant stony loam, 0 to 5 percent slopes. This very deep, well drained soil is on alluvial fans. It formed in loess overlying cobbly or gravelly alluvium. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 2,400 to 2,600 feet. The average annual precipitation is 14 to 17 inches, the average annual air temperature is about 48 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 1/2 inch thick. The surface layer is grayish brown stony loam about 8 inches thick. The subsoil is brown gravelly loam and pale brown very gravelly loam about 10 inches thick. The substratum to a depth of 60 inches or more is pale brown extremely gravelly sandy loam. In some areas the part of the soil profile below the surface layer is gravelly.

Included in this unit are small areas of Wenas soils in poorly drained, depressional areas and Mippon soils near stream channels. Included areas make up about 15 percent of the total acreage.

Permeability of this Sutkin Variant soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight.

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 70 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 50 years of age is 55 cubic feet per acre. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 45 cubic feet per acre. However, the typical basal area of stands on this unit is about 60 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. The numerous stones on the surface of many areas of this unit may hinder harvesting. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs periodically. The droughtiness of the soil in this unit increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, lupine, American vetch, common snowberry, and ceanothus. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This unit is limited for livestock watering ponds and other water impoundments because of seepage. Spring developments, wells, and pipeline systems can be used to provide water for livestock.

This map unit is in capability subclass VIs, nonirrigated.

151-Taneum loam, 5 to 15 percent slopes. This very deep, well drained soil is on uplands. It formed in loess overlying weathered sandstone. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,300 to 3,000 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the surface layer is dark grayish brown and grayish brown loam about 14 inches thick. The upper part of the subsoil is brown silty clay loam about 13 inches thick, and the lower part is brown clay loam about 16 inches thick. The upper part of the substratum is yellowish brown loam about 7 inches thick, and the lower part to a depth of 60 inches or more is brown sandy loam. In some areas bedrock is at a depth of 40 to 60 inches.

Included in this unit are areas of Rock Creek, McDaniel, and Roza soils.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Spring grain can be grown during years when extra moisture is received. The amount of straw produced by spring grain generally is

not sufficient for erosion control unless it is very carefully managed.

Growing grasses and legumes in the rotation helps to control erosion and to maintain or improve tilth. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. This unit has few limitations for the production of forage. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitations are shrink-swell potential and steepness of slope. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for the use of septic tank absorption fields is the moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be avoided by installing absorption lines on the contour.

This map unit is in capability subclass IIIe, nonirrigated.

152-Taneum loam, 15 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in loess overlying weathered sandstone. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,300 to 3,000 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the surface layer is dark grayish brown and grayish brown loam about 14 inches thick. The upper part of the subsoil is brown silty clay loam about 13 inches thick, and the lower part is brown clay loam about 16 inches thick. The upper part of the substratum is yellowish brown loam about 7 inches thick, and the lower part to a depth of 60 inches or more is brown sandy loam. In some areas bedrock is at a depth of 40 to 60 inches.

Included in this unit are areas of Rock Creek, McDaniel, and Roza soils.

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

This unit is used for nonirrigated crops, rangeland, wildlife habitat, and homesites.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Spring grain can be grown during years when extra moisture is received.

Growing grasses and legumes in the rotation helps to control erosion and to maintain or improve tilth. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Fall seeding, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Diversions may be needed to intercept runoff from higher lying areas. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. This unit has few limitations for the production of forage. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are steepness of slope and moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for the moderately slow permeability. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclass IVe, nonirrigated.

153-Taneum loam, 30 to 60 percent slopes. This very deep, well drained soil is on uplands. It formed in loess overlying weathered sandstone. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 2,300 to 3,000 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the surface layer is dark grayish brown and grayish brown loam about 14 inches thick. The upper part of the subsoil is brown silty clay loam about 13 inches thick, and the lower part is brown clay loam about 16 inches thick, The upper part of the substratum is yellowish brown loam about 7 inches thick, and the lower part to a depth of 60 inches or more is brown sandy loam. In some areas bedrock is at a depth of 40 to 60 inches.

Included in this unit are areas of Rock Creek, McDaniel, and Roza soils and Rock outcrop.

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

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. This unit has few limitations for the production of forage. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Proper placement of salt licks, livestock watering facilities, and fences promotes more uniform distribution of grazing.

Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Plant competition can be reduced by using chemicals. Range seeding is a suitable practice if the range vegetation is in poor condition. Use of equipment in some areas is limited by steepness of slope. Fall seedings generally are most successful. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIIe, nonirrigated.

154-Taneum-Rock Creek complex, 5 to 15 percent slopes. This map unit is on uplands. The native vegetation is mainly grasses, forbs, and shrubs. The elevation is 2,300 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 135 days.

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

Included with this unit are areas of Clint and McDaniel soils. Included areas make up about 20 percent of the total acreage.

The Taneum soil is very deep and well drained. It formed in loess overlying weathered sandstone. Typically, the surface layer is dark grayish brown and grayish brown loam about 14 inches thick. The upper part of the subsoil is brown silty clay loam about 13 inches thick, and the lower part is brown clay loam about 16 inches thick. The upper part of the substratum is yellowish brown loam about 7 inches thick, and the lower part to a depth of 60 inches or more is brown sandy loam.

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

The Rock Creek soil is shallow and well drained. It formed in loess and residuum derived dominantly from basalt. Typically, the surface layer is grayish brown very stony silt loam about 2 inches thick. The subsoil is brown very cobbly clay about 8 inches thick. Basalt is at a depth of about 10 inches. Depth to basalt ranges from 8 to 15 inches. In some areas the surface layer is stony, and in some areas bedrock is at a depth of more than 20 inches.

Permeability of the Rock Creek soil is moderately slow. Available water capacity is low. Effective rooting depth is 8 to 15 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation of the Taneum soil is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. This soil has few limitations for the production of forage. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases.

The potential native vegetation of the Rock Creek soil is mainly stiff sagebrush, Sandberg bluegrass, and eriogonum. The main limitations for the production of forage are depth to rock and low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as stiff sagebrush and Sandberg bluegrass decreases and the proportion of less preferred forage plants such as forbs and annual grasses increases.

Areas of the Taneum soil that are heavily infested with undesirable vegetation can be improved with such methods as chaining, railing, beating, chemical treatment, and prescribed burning. Range seeding on the Rock Creek soil is not feasible because of the low available water capacity and depth to rock. Range seeding on the Taneum soil is a suitable practice if the

range vegetation is in poor condition. The soil should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This map unit is in capability subclass VIs, nonirrigated.

155-Tekison stony loam, 0 to 25 percent slopes. This very deep, well drained soil is on ridges and benches. It formed in residuum and colluvium derived from basalt and containing small amounts of loess. The native vegetation is mainly conifers, grasses, and shrubs. Elevation is 2,800 to 3,600 feet. The average annual precipitation is 16 to 20 inches, the average annual temperature is about 47 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 170 days.

Typically, the surface layer is brown stony loam about 4 inches thick. The upper part of the subsoil is brown stony loam about 8 inches thick, the next part is brown very cobbly clay loam about 8 inches thick, and the lower part to a depth of 60 inches or more is yellowish brown very gravelly clay and very cobbly clay.

Included in this unit are small areas of Meystre, Odo, and Rock Creek soils and areas of Tekison soils that have slopes of more than 25 percent.

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

This unit is used as grazable woodland and for wildlife habitat.

Ponderosa pine and Douglas-fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 69 for ponderosa pine and 80 for Douglas-fir. Yield tables for normal, even-aged, unmanaged stands indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger is 54 cubic feet per acre for ponderosa pine at age 55 and 69 cubic feet per acre for Douglas-fir at age 40. The mean annual increment for trees 6.6 inches in diameter and larger at 80 years of age is 44 cubic feet per acre for ponderosa pine and 56 cubic feet per acre for Douglas-fir. However, the typical basal area of stands on this unit is about 95 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is a short period of seasonal soil wetness. Unsurfaced roads and skid trails are slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine occurs infrequently. The droughtiness of the soil increases seedling mortality, especially on south- and southwest-facing slopes.

The common forest understory plants are elk sedge, pinegrass, western yarrow, and bitterbrush. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is well suited to grazing and browsing. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIs, nonirrigated.

156-Tieton fine sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in material derived from andesite. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1.500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown fine sandy loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is loam or stony loam. In some areas sandstone is at a depth of 40 to 60 inches, and in some areas andesite is at a depth of more than 60 inches.

Included in this unit are areas of Simcoe and Rock Creek soils and Rock outcrop. Also included are areas of soils that have a high water table.

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

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazards of soil blowing and water erosion. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of irrigation system used depends on the kind of crop grown. If furrow and corrugation irrigation systems are used, runs should be on the contour or across the slope. The hazard of water erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Pipe, ditch

lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Using a cropping system that includes close-growing, high-residue crops in the rotation, maintaining crop residue on the surface, and using minimum tillage reduce erosion. Return of crop residue to the soil also helps to maintain or improve the organic matter content and to maintain tilth. A plowpan develops in this soil from excessive tillage with heavy equipment. Growing annual cover crops in orchards and vineyards reduces erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitations are depth to rock and shrink-swell potential. Bedrock hinders excavation. If buildings are constructed on the soil in this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIe, irrigated.

157-Tieton loam, 0 to 2 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in material derived from andesite. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is stony, and in some areas sandstone is at a depth of 40 to 60 inches.

Included in this unit are small areas of Simcoe, Rock Creek, and Ritzville soils and Rock outcrop. Also included are areas of soils that have a seasonal high water table.

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

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

This unit has few limitations for irrigated crops. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or increase the organic matter content, help to maintain tilth, and increase the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Use of cover crops reduces erosion in orchards and vineyards. A plowpan develops in this soil, but it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitations for homesites are depth to rock and shrink-swell potential. The bedrock hinders excavation. If buildings are constructed on the soil in this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation.

This map unit is in capability class I, irrigated.

158-Tieton loam, 2 to 5 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in material derived from andesite. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60

inches. In some areas the surface layer is fine sandy loam or is stony, and in some small areas sandstone is at a depth of 40 to 60 inches.

Included in this unit-are areas of Simcoe, Rock Creek, and Ritzville soils, Rock outcrop, and soils that have a seasonal high water table.

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

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping the runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Use of annual or perennial cover crops during the irrigation season reduces erosion in orchards and vineyards. A plowpan develops in this soil, but it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitations are depth to rock and shrink-swell potential. The bedrock hinders excavation. If buildings are constructed on the soil in this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIe, irrigated.

159-Tieton loam, 5 to 8 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in material derived from andesite. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is fine sandy loam, and in a few small areas sandstone is at a depth of 40 to 60 inches.

Included in this unit are areas of Simcoe, Rock Creek, and Ritzville soils, areas of Rock outcrop, and areas of soils that have a seasonal high water table.

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

This unit is used for irrigated field and orchard crops (fig. 5), for wildlife habitat, and as homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to

Figure 5.-Orchard on Tieton loam, 5 to 8 percent slopes, in the center. Wind machines in the orchard reduce the hazard of frost.

the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Growing cover crops helps to control erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitations are depth to rock and shrink-swell potential. The bedrock hinders excavation. If building are constructed on the soil in this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIIe, irrigated.

160-Tieton loam, 8 to 15 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in material derived from andesite. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60

inches. In some areas sandstone is at a depth of 40 to 60 inches.

Included in this unit are areas of Simcoe, Rock Creek, and Ritzville soils, areas of Rock outcrop, small areas of soils that have a seasonal high water table, and areas of Tieton soils that have slopes of less than 8 percent.

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

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain and tree fruit. Grasses and legumes are grown for hay, pasture, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Use of annual or perennial cover crops reduces erosion in orchards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are the hazard of water erosion and low annual precipitation. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding early in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations are steepness of slope, depth to rock, and shrink-swell potential. The bedrock hinders excavation. If buildings are constructed on the soil in this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is the moderately slow permeability. Use of sandy backfill for the trench and long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour.

This map unit is in capability subclasses IVe, irrigated, and IIIe, nonirrigated.

161-Tieton loam, 15 to 30 percent slopes. This deep, well drained soil is on uplands. It formed in loess and in material derived from andesite. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60 inches. In some areas sandstone is at a depth of 40 to 60 inches.

Included in this unit are areas of Simcoe, Rock Creek, and Ritzville soils and Rock outcrop.

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

This unit is used for irrigated field and orchard crops, nonirrigated crops, wildlife habitat, rangeland and homesites. The main irrigated crops are grain and tree fruit. Grass and legumes are grown for hay, pasture, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of

irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Growing perennial cover crops reduces erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Seeding in fall, either on the contour or across the slope, slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, plowing, beating, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are steepness of slope and the moderately slow permeability. Use of long absorption lines and sandy backfill for the trench helps to compensate for the moderately slow permeability. Slope can cause lateral seepage and surfacing of effluent in downslope areas.

This map unit is in capability subclasses IVe, irrigated and nonirrigated.

162-Tieton-Rock outcrop complex, 0 to 30 percent slopes. This map unit is on uplands (fig. 6). The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

This unit is about 60 percent Tieton loam and about 25 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Ritzville and Simcoe soils. Included areas make up about 15 percent of the total acreage.

The Tieton soil is deep and well drained. It formed in loess and in material derived from andesite. Typically, the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is brown loam about 6 inches thick, and the lower part is yellowish brown and brown silty clay loam and clay loam about 29 inches thick. The substratum is grayish brown loam about 4 inches thick. Andesite is at a depth of about 48 inches. Depth to andesite ranges from 40 to 60 inches. In some areas sandstone is at a depth of 40 to 60 inches, and in some areas andesite or sandstone is at a depth of more than 60 inches.

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

Rock outcrop is areas of exposed bedrock.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation on the Tieton soil is mainly bluebunch wheatgrass, Idaho fescue, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass and Idaho fescue decreases and the proportion of less preferred forage plants such as rabbitbrush and big sagebrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chemical treatment and prescribed burning. Because the areas of the Tieton soil are not large enough to effectively seed using a drill, proper range use, deterred grazing, and rotation grazing are the most effective methods of range management and erosion control. Fences are needed in most areas to prevent cattle from grazing in adjacent orchards.

This map unit is in capability subclass VIs, nonirrigated.

163-Toppenish silt loam. This very deep, artificially drained soil is on flood plains. It formed in alluvium. Slope is 0 to 2 percent. The native vegetation is water-tolerant grasses and deciduous trees. Elevation is 700 to 1,800 feet. The average annual precipitation is 8 to 10 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is dark grayish brown, strongly alkaline silt loam about 4 inches thick. The upper part of the subsoil is gray, strongly alkaline silty clay loam about 10 inches thick, and the lower part is

Figure 6.-Typical area of Tieton-Rock outcrop complex, 0 to 30 percent slopes. Grasses and orchard are on Tieton soils in foreground.

gleyed, dark grayish brown and brown, moderately alkaline and mildly alkaline silt loam about 36 inches thick. The substratum to a depth of 60 inches or more is brown, mildly alkaline extremely gravelly sand. In some areas the surface layer is silty clay loam.

Included in this unit are small areas of Wenas, Track, Kittitas, Fiander, Esquatzel, and Naches soils and areas of Toppenish soils that have not been artificially drained.

Permeability of this Toppenish soil is moderately slow to the substratum and very rapid through it. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 48 inches from June to November. Runoff is very slow, and the hazard of water erosion is slight. This unit is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Where areas of this unit are drained, the main irrigated crops are asparagus, corn, grain, and peas. Grasses and legumes are grown for hay and pasture.

The main limitation for irrigated crops is wetness. Deep-rooted crops are suited to areas where a drainage system has been installed and is maintained. Dikes are effective in diverting floodwater and they need to be maintained to provide continuing protection from flooding. If drainage systems are not maintained, the soil in this unit has a high water table during the irrigation season.

Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of irrigation system used depends on the kind of crop grown. If surface systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler and drip irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of

irrigation water should also be adjusted to the available water capacity and the crop needs.

Proper timing of minimum tillage and return of crop residue to the soil help to avoid soil compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

Where the soil in this unit is not adequately drained, the main limitations for use as homesites are the hazard of flooding and wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Ground cover that is adapted to alkaline soil should be used.

The main limitations for septic tank absorption fields are wetness and the moderately slow permeability. Moderately slow permeability and the seasonal high water table increase the possibility of failure of septic tank absorption fields.

This map unit is in capability subclass IIIw, irrigated.

164-Torriorthents, steep. These shallow and moderately deep, well drained soils are on uplands. They formed in material derived from mixed sources and containing a small amount of loess. Slope is 30 to 60 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 1,600 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 160 days.

No single profile is typical of Torriorthents, but one commonly observed in the survey area has a surface layer of brown gravelly sandy loam about 4 inches thick. The underlying material is light brownish gray very gravelly sandy loam and gravelly sand about 27 inches thick. Soft, tuffaceous sandstone is at a depth of about 31 inches. Depth to sandstone, old gravelly alluvium, or lake sediment ranges from 10 to 40 inches. Texture of these soils varies widely within short distances. In some areas the surface layer is very gravelly.

Included in this unit are Roza, Harwood, Gorst, and Cowiche soils and areas of Rock outcrop.

Permeability of Torriorthents is rapid to the sandstone and slow through it. Available water capacity ranges from low to high. Effective rooting depth is 10 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. The main limitation for the production of forage is low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Brush control is limited to aerial chemical applications and prescribed burning because of the steepness of slope and hazard of water erosion. Seeding is not feasible because of the low available water capacity. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Proper location of salt licks, stock water, and fences promotes more uniform distribution of grazing. Other management practices suitable for use on this unit are proper range use, deferred grazing, and rotation grazing.

This map unit is in capability subclass VIIe, nonirrigated.

165-Track loam. This very deep, artificially drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 2 percent. The native vegetation is water-tolerant grasses and forbs. Elevation is 800 to 1,500 feet. The average annual precipitation is 8 to 10 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is dark grayish brown, strongly alkaline loam about 14 inches thick. The upper part of the subsoil is grayish brown, strongly alkaline very gravelly loam about 7 inches thick, and the lower part is brown, strongly alkaline very gravelly loam about 5 inches thick. The substratum to a depth of 60 inches or more is brown, moderately alkaline very gravelly loamy sand. In some areas the surface layer is silty clay loam or very gravelly loam.

Included in this unit are areas of Ashue, Toppenish, Weirman, and Zillah soils. Also included are areas of salt- and alkali-affected soils, ponded soils, and Track soils that have not been artificially drained or have slopes of more than 2 percent.

Permeability of this Track soil is moderately slow. Available water capacity is moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 48 inches from June to November. Runoff is very slow, and the hazard of water erosion is slight. This soil is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are asparagus, corn, grain, and peas. Grasses and legumes are grown for hay and pasture.

The main limitations for irrigated crops are wetness and low available water capacity. Deep-rooted crops are suited to areas where a drainage system has been installed and maintained. Dikes are effective in diverting floodwater, but they need to be maintained to provide

continuing protection from flooding. If drainage systems are not maintained, the soil in this unit has a high water table during the irrigation season.

Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of irrigation system used depends on the kind of crop grown. If surface irrigation is used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to avoid compaction, to maintain or improve the organic matter content, to maintain tilth, and to improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Exposing the very gravelly subsoil during leveling should be avoided. Shallow cuts are feasible in some areas.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are wetness and seepage. The seasonal high water table can increase the possibility of the failure of absorption fields. Care should be taken to prevent the contamination of water supplies as a result of seepage.

This map unit is in capability subclass IIIw, irrigated.

166-Tumac very stony sandy loam, 5 to 45 percent slopes. This very deep, well drained soil is on south-facing side slopes of uplands and mountains. It formed in colluvium derived from basalt and andesite and containing volcanic ash. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 4,100 to 5,200 feet. The average annual precipitation is 30 to 60 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer is brown very stony sandy loam about 4 inches thick, and the lower part is brown very gravelly loam about 11 inches thick. The upper part of the subsoil is yellowish brown very gravelly loam about 15 inches thick, and the lower part to a depth of 60 inches or more is yellowish brown and strong brown extremely gravelly loam. In some areas the subsoil is gravelly loam.

Included in this unit are areas of Tumac soils that have slopes of 45 to 60 percent and poorly drained soils in small depressional areas.

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

This unit is used as grazable woodland and for wildlife habitat.

Lodgepole pine, grand fir, and Douglas-fir are the main woodland species on the soil in this unit. Among the trees of limited extent are ponderosa pine, western larch, Engelmann spruce and subalpine fir. On the basis of 100-year site curve, the mean site index is 88 for Douglas-fir, 87 for grand fir, 90 for lodgepole pine, and 73 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands of Douglas-fir indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 40 years of age is 82 cubic feet per acre. The mean annual increment for Douglas-fir trees 6.6 inches in diameter and larger at 80 years of age is 70 cubic feet per acre. The mean annual increment at culmination for lodgepole pine at 100 years of age is about 100 cubic feet per acre. However, the typical basal area of stands on this unit is about 85 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is the difficulty of using wheeled and tracked equipment where slopes are more than 30 percent. Use of wheeled and tracked equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trails are soft and slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by grand fir and lodgepole pine occurs readily. This can delay establishment of planted seedlings.

The common forest understory plants are elk sedge, pinegrass, lupine, pachystima, and Oregon-grape. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is well suited to grazing and browsing. Seeding to adapted

grazable vegetation following logging or burning late in summer or in fall generally is most successful.

This map unit is in capability subclass VIIs, nonirrigated.

167-Tumac very stony sandy loam, 45 to 65 percent slopes. This very deep, well drained soil is on south-facing mountainsides. It formed in colluvium derived from basalt and andesite and containing volcanic ash. The native vegetation is mainly conifers, grasses, forbs, and shrubs. Elevation is 4,100 to 5,200 feet. The average annual precipitation is 30 to 60 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typically, the surface is covered with a mat of partially decomposed organic material about 2 inches thick. The upper part of the surface layer is brown very stony sandy loam about 4 inches thick, and the lower part is brown very gravelly loam about 11 inches thick. The upper part of the subsoil is yellowish brown very gravelly loam about 15 inches thick, and the lower part to a depth of 60 inches or more is yellowish brown and strong brown extremely gravelly loam. In some areas the subsoil is gravelly loam.

Included in this unit is about 10 percent Rock outcrop and Rubble land. Also included are areas of Tumac soils that have slopes of less than 45 percent.

Permeability of this Tumac soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used as grazable woodland and for wildlife habitat.

Lodgepole pine, grand fir, and Douglas-fir are the main woodland species on the soil in this unit. Among the trees of limited extent are ponderosa pine, western larch, Engelmann spruce, and subalpine fir. On the basis of a 100-year site curve, the mean site index is 88 for Douglas-fir, 87 for grand fir, 90 for lodgepole pine, and 73 for ponderosa pine. Yield tables for normal, even-aged, unmanaged stands of Douglas-fir indicate that the mean annual increment at culmination (CMAI) for trees 0.6 inch in diameter and larger at 40 years of age is 82 cubic feet per acre. The mean annual increment for Douglas-fir trees 6.6 inches in diameter and larger at 80 years of age is 70 cubic feet per acre. The mean annual increment at culmination is about 100 cubic feet per acre for lodgepole pine at 100 years of age. However, the typical basal area of stands on this unit is about 85 percent that of normal stands, and the total yield is correspondingly lower.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer, and they disturb the soil less. Use of wheeled and tracked equipment when the soil is moist can produce ruts, compact the soil, and damage tree roots. Unsurfaced roads and skid trails are soft and slippery when wet, and they may be impassable during spring runoff or in rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is available in the included areas of Rock outcrop and Rubble land. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir and ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by grand fir and lodgepole pine occurs readily. This can delay establishment of planted seedlings.

The common forest understory plants are elk sedge, pinegrass, lupine, pachystima, and Oregon-grape. The crown density in the areas where the woodland site index was measured is 25 percent. This unit is suited to browsing. The main limitation for the production of forage is steepness of slope, which limits access by livestock. Seeding to adapted grazable vegetation following logging or burning late in summer or in fall generally is most successful. Because of the steepness of slope, broadcast seeding should be used.

This map unit is in capability subclass VIIs, nonirrigated.

168-Umapine silt loam, 0 to 5 percent slopes. This very deep, somewhat poorly drained, salt- and alkali-affected soil is on flood plains and low terraces. It formed in alluvium. The native vegetation is mainly salt- and alkali-tolerant grasses, forbs, and shrubs. Elevation is 650 to 900 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is light brownish gray, very strongly alkaline silt loam about 7 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray and light gray, very strongly alkaline and strongly alkaline silt loam. In some areas the surface layer is dark gray.

Included in this unit are areas of Esquatzel, Toppenish, and Warden soils. Also included are areas of soils that are underlain by a hardpan at a depth of 20 to 40 inches.

Permeability of this Umapine soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 42 inches from November to June. Runoff is very slow, and the hazard of water erosion is slight. The soil is subject to occasional periods of flooding in spring.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly basin wildrye, inland saltgrass, and black greasewood. The main limitations for the production of forage are seasonal soil wetness and the alkalinity of the soil. If the range is overgrazed, the proportion of preferred forage plants such as basin wildrye decreases and the proportion of less preferred forage plants such as inland saltgrass and quackgrass increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The unit should be seeded in fall using a drill. Grasses adapted to the alkaline condition of the soil should be seeded.

This map unit is in capability subclass VIw, nonirrigated.

169-Umapine silt loam, drained, 0 to 2 percent slopes. This very deep, artificially drained, salt- and alkali-affected soil is on flood plains and low terraces. It formed in alluvium. The native vegetation is mainly salt- and alkali-tolerant grasses, forbs, and shrubs. Elevation is 650 to 900 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is light brownish gray, very strongly alkaline silt loam about 7 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray and light gray, very strongly alkaline and strongly alkaline silt loam. In some areas the surface layer is dark gray.

Included in this unit are areas of Esquatzel, Toppenish, Kittitas, and Warden soils. Also included are areas of soils that are underlain by a hardpan at a depth of 20 to 40 inches and areas of Umapine soils that have not been artificially drained.

Permeability of this Umapine soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 24 to 48 inches from November to June. Runoff is very slow, and the hazard of water erosion is slight. The soil is subject to rare periods of flooding.

This unit is used for irrigated crops, wildlife habitat, and homesites. The main irrigated crops are asparagus, corn, hops, grain, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are wetness, alkalinity, and the hazard of water erosion. Reclamation of the soil in this unit may require the addition of such amendments as gypsum, sulfur, or ferric sulfate to facilitate leaching and reduce alkalinity. Unless drainage systems are maintained, the soil has a seasonal high water table during the irrigation season. Dikes need to be maintained to provide continuing protection from flooding.

Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation is used, the hazard of erosion can be minimized by keeping runs short. Sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Proper timing of tillage, use of minimum tillage, and return of crop residue to the soil help to avoid compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and wetness. Flooding can be controlled by the use of dikes and channels that have outlets to bypass floodwater. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is wetness. Deep drainage helps to overcome this limitation.

This map unit is in capability subclass IIIw, irrigated.

170-Umapine silt loam, drained, 2 to 5 percent slopes. This very deep, artificially drained, salt- and alkali-affected soil is on flood plains and low terraces. It formed in alluvium. The native vegetation is mainly salt- and alkali-tolerant grasses, forbs, and shrubs. Elevation is 650 to 900 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is light brownish gray, very strongly alkaline silt loam about 7 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray and light gray, very strongly alkaline and strongly alkaline silt loam. In some areas the surface layer is dark gray.

Included in this unit are areas of Esquatzel, Toppenish, and Warden soils. Also included are areas of soils that

are underlain by a hardpan at a depth of 20 to 40 inches and Umapine soils that have not been artificially drained.

Permeability of this Umapine soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 24 to 48 inches from November to June. Runoff is very slow, and the hazard of water erosion is moderate. This unit is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are asparagus, corn, hops, peas, and grain. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are alkalinity and the hazard of water erosion. Reclamation of the soil in this unit may require the addition of such amendments as gypsum, sulfur, or ferric sulfate to facilitate leaching and reduce alkalinity. Unless drainage systems are maintainers the soil has a seasonal high water table during the irrigation season. Dikes need to be maintained to provide protection from flooding.

Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation is used, runs should be on the contour or across the slope. Sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, application of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows greatly reduces erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and wetness. Flooding can be controlled by the use of dikes and channels that have outlets to bypass floodwater. Wetness can be reduced by installing drain tile around footings. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is wetness. Deep drainage helps to overcome this limitation.

This map unit is in capability subclass IIIw, irrigated.

171-Wanser loamy fine sand. This very deep, artificially drained, salt- and alkali-affected soil is on terraces in basins. It formed in sand. Slope is 0 to 5 percent. The native vegetation is mainly salt- and alkali-tolerant grasses and forbs. Elevation is 650 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 135 days.

Typically, the surface layer is grayish brown, moderately alkaline loamy fine sand about 6 inches thick. The upper part of the underlying material is dark grayish brown and grayish brown, moderately alkaline and strongly alkaline loamy fine sand about 51 inches, and the lower part to a depth of 60 inches or more is light brownish gray, strongly alkaline fine sand.

Included in this unit are areas of Hezel, Quincy, and Esquatzel soils and areas of Wanser soils that have not been artificially drained.

Permeability of this Wanser soil is rapid. Available water capacity is moderately high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. A seasonal high water table is at a depth of 42 to 60 inches from January to June. The soil is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are grain and corn. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are wetness, low available water capacity, and the hazard of soil blowing. Deep-rooted crops are suited to areas where the drainage is adequate or where a drainage system has been installed and is maintained. Reclamation of the soil in this unit may require the addition of such amendments as gypsum, sulphur, or ferric sulfate to facilitate leaching. Unless drainage systems are maintained, the soil has a seasonal high water table during the irrigation season. Dikes need to be maintained to provide protection for flooding.

Sprinkler irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of irrigation water, reduces runoff, and minimizes the risk of water erosion. The type of irrigation system used depends on the kind of crop grown. To avoid leaching of plant nutrients and loss of water by deep percolation, the water application rate should be adjusted to the available water capacity, the water intake rate, and the crop needs. Frequent, light applications of irrigation water are needed because of the rapid permeability of the soil.

The high hazard of soil blowing makes tillage and residue management extremely important. The soil should not be left barren while it is subject to erosion in winter and spring. Winter cover crops should be planted early and at right angles to the prevailing wind. Fall grain, hay, and pasture should be seeded late in August or early in September to provide sufficient cover in winter. Seedbed preparation should be done when irrigation water is available to keep the soil surface moist. Sufficient crop residue should be left on the surface. Use of straw, manure, or other waste material as a mulch reduces soil blowing, helps to maintain or improve the organic matter content, and conserves moisture. Use of shelterbelts also reduces soil blowing.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Flooding can be controlled by use of dikes and channels that have outlets to bypass floodwater. Because of the high hazard of soil blowing, construction sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitations for septic tank absorption fields are wetness and seepage. Wetness increases the possibility of the failure of the septic tank absorption fields. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IVw, irrigated.

172-Warden fine sandy loam, 0 to 2 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is silt loam, and in some areas the soil is calcareous throughout.

Included in this unit are areas of Shano, Burke, Harwood, Wiehl, and Esquatzel soils.

Permeability of this Warden soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is high.

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of soil blowing. Furrow, corrugation, trickle, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of irrigation system used depends on the kind of crop grown. Use of sprinkler and drip irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces erosion. The soil should be protected from erosion by growing a cover crop or by maintaining crop residue on the surface in spring or until the crops are well established. Crop rows and irrigation furrows should be placed at right angles to the prevailing wind where feasible to reduce soil blowing. Vegetative barriers and windbreaks also reduce soil blowing. Mulching may be needed to stabilize small areas where soil blowing begins. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduce the volume of sediment in the tailwater.

This unit is well suited to homesite development. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclass IIe, irrigated.

173-Warden fine sandy loam, 2 to 5 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is silt loam.

Included in this unit are small areas of Shano, Harwood, Burke, Wiehl, Outlook, and Esquatzel soils and Warden soils that have slopes of less than 2 percent.

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

The unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and

homesites. The main irrigated crops are corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazards of soil blowing and water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow and corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of water erosion can be minimized by keeping runs short. Use of sprinkler and drip irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of water erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces erosion. The soil should be protected from erosion by growing cover crops or maintaining crop residue on the surface in spring or until the crop is well established. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Vegetative barriers and windbreaks reduce soil blowing. Mulching may be needed to stabilize small areas where soil blowing begins.

Growing mint in meadows rather than in rows greatly reduces water erosion. A plowpan develops in this soil; however, it can be broken by subsoiling. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

The main limitations for nonirrigated crops are low annual precipitation and the hazards of soil blowing and water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early and stubble mulching. Stripcropping and seeding at right angles to the prevailing wind reduce soil blowing. Drop structures are needed in a few places to stabilize the flow of runoff in waterways. Waterways may need to be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Soil blowing can be a concern during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclasses IIe, irrigated, and IVe, nonirrigated.

174-Warden fine sandy loam, 5 to 8 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is silt loam.

Included in this unit are small areas of Shano soils.

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

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazards of soil blowing and water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces erosion. The soil should be protected from soil blowing by maintaining crop residue on the surface in spring or until the crops

are well established. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Vegetative barriers and windbreaks also reduce soil blowing. Mulching may be needed to stabilize small areas where soil blowing begins. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when soil is dry.

The potential native vegetation is mainly bluebunch wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in the fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Soil blowing is a concern during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclasses IIIe, irrigated, and IVe, nonirrigated.

175-Warden fine sandy loam, 8 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is silt loam.

Included in this unit are small areas of Shano soils, soils that have a salt- and alkali-affected surface layer, and Warden soils that have slopes of less than 8 percent.

Permeability of this Warden soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, and tree fruit. Grasses and legumes are grown for pasture, hay, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazards of soil blowing and water erosion. A rotation of grain followed by alfalfa and grass commonly is used. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce the risk of soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces erosion. The soil should be protected from soil blowing by maintaining crop residue on the surface in spring or until the crops are well established. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Vegetative barriers and windbreaks also reduce soil blowing. Mulching may be needed to stabilize small areas where soil blowing begins. Cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazards of soil blowing and water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, stripcropping, and seeding at right angles to the prevailing wind. Drop structures are needed in a few areas to stabilize the flow of runoff in waterways. Waterways may need to be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and needleandthread. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for use as homesites and septic tank absorption fields is steepness of slope. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be avoided by installing absorption lines on the contour. Soil blowing may be a

problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

176-Warden silt loam, 0 to 2 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Shano, Harwood, Wiehl, Burke, and Esquatzel soils and areas of salt- and alkali-affected soils.

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

This unit is used for irrigated field and orchard crops, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, grapes, hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

This unit has few limitations for crops. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is well suited to homesite development. Dustiness is a concern during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability class I, irrigated.

177-Warden silt loam, 2 to 5 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Shano, Harwood, Burke, Wiehl, and Esquatzel soils. Also included are areas of salt- and alkali- affected soils and areas of Warden soils that have slopes of less than 2 percent or more than 5 percent.

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

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes (fig. 7), hops, mint, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and

Figure 7-Vineyard under drip irrigation on Warden silt loam, 2 to 5 percent slopes.

leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and reduce ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows greatly reduces erosion. Growing cover crops reduces erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, and shaping waterways and seeding them to perennial grass. Drop structures are needed in a few areas to stabilize the flow of runoff in waterways.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are

heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit is in capability subclass IIe, irrigated and IVe, nonirrigated.

178-Warden silt loam, 5 to 8 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Shano soils and areas of Warden soils that have slopes of less than 5 percent or more than 8 percent.

Permeability of this Warden soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, peas, and tree fruit. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is well suited to homesite development. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This unit has few limitations for septic tank absorption fields.

This map unit in is capability subclass IIIe, irrigated.

179-Warden silt loam, 8 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Harwood, Burke, Wiehl, Esquatzel, and Shano soils. Also included are areas of soils that have a salt- and alkali-affected surface layer and soils that have slopes of less than 8 percent or more than 15 percent.

Permeability of this Warden soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grapes and tree fruit. Grass and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation improves the infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is suited to homesite development. The main limitation for use as homesites and septic tank absorption fields is steepness of slope. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Lateral seepage can be reduced by installing absorption lines on the contour. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

180-Warden silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on terraces. It formed in lacustrine sediment and has a mantle of loess. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typically, the surface layer is brown silt loam about 5 inches thick. The subsoil is pale brown silt loam about 14 inches thick. The substratum to a depth of 60 inches or more is light gray and pale brown, stratified silt loam, loam, and very fine sandy loam. In some areas the surface layer is fine sandy loam.

Included in this unit are small areas of Shano, Scooteney, and Burke soils. Also included are areas of soils that have a salt- and alkali-affected surface layer and areas of Warden soils that have slopes of less than 15 percent or more than 30 percent.

Permeability of this Warden soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated field and orchard crops, nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are grain, grapes, and tree fruit. Grass and legumes are grown for hay, pasture, and seed. A cover crop is grown in orchards.

The main limitations for irrigated crops are steepness of slope and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation increases the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to reduce runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Using a cropping system that includes close-growing, high-residue crops in the rotation reduces water erosion. Cover crops reduce erosion in orchards and vineyards. A plowpan develops in this soil from excessive tillage; however, it can be broken by chiseling or subsoiling when the soil is dry.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion.

Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, divided-slope farming, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass and Sandberg bluegrass. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for homesites and septic tank absorption fields is steepness of slope. Slope can cause lateral seepage and surfacing of effluent in downslope areas. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

181-Weirman sandy loam, channeled. This very deep, somewhat excessively drained soil is on low terraces and flood plains (fig. 8). The soil is dissected by intermittent and perennial streams. It formed in mixed alluvium. Slope is 0 to 5 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 14 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown sandy loam about 8 inches thick. The upper part of the underlying material is grayish brown and light brownish gray loamy fine sand about 13 inches thick, and the lower part to a depth of 60 inches or more is grayish brown extremely gravelly sand. In some areas the surface layer is fine sandy loam or is gravelly, cobbly, or stony sandy loam.

Included in this unit are areas of Zillah, Logy, and Yakima soils.

Permeability of this Weirman soil is rapid. Available water capacity is low. Effective rooting depth is limited by a seasonal high water table that is at a depth of 36 to 60 inches from April to November. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. This unit is subject to frequent periods of flooding in spring.

This unit is used as rangeland and for wildlife habitat.

The potential native vegetation is mainly basin wildrye, bluebunch wheatgrass, big bluegrass, and willows. The main limitation for the production of forage is low available water capacity. If the range is overgrazed, the proportion of preferred forage plants such as basin wildrye and bluebunch wheatgrass decreases and the proportion of less preferred plants increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition, but seeding is difficult because of the areas that have cobbly or stony surface layer. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is limited for livestock watering ponds and other water impoundments because of seepage potential. Water tanks, springs, and pipeline systems are more effective and reliable means of providing water for livestock.

This map unit is in capability subclass Vlw, nonirrigated.

182-Weirman fine sandy loam. This very deep, somewhat excessively drained soil is on low terraces and flood plains. It formed in mixed alluvium. Slope is 0 to 2 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 14 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The upper part of the underlying material is stratified, grayish brown and light brownish gray loamy fine sand about 13 inches thick, and the lower part to a depth of 60 inches or more is grayish brown extremely gravelly sand.

Included in this unit are areas of Ashue, Zillah, Logy, and Yakima soils.

Permeability of this Weirman soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. The soil is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, grapes, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazard of soil blowing and low available water capacity. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping

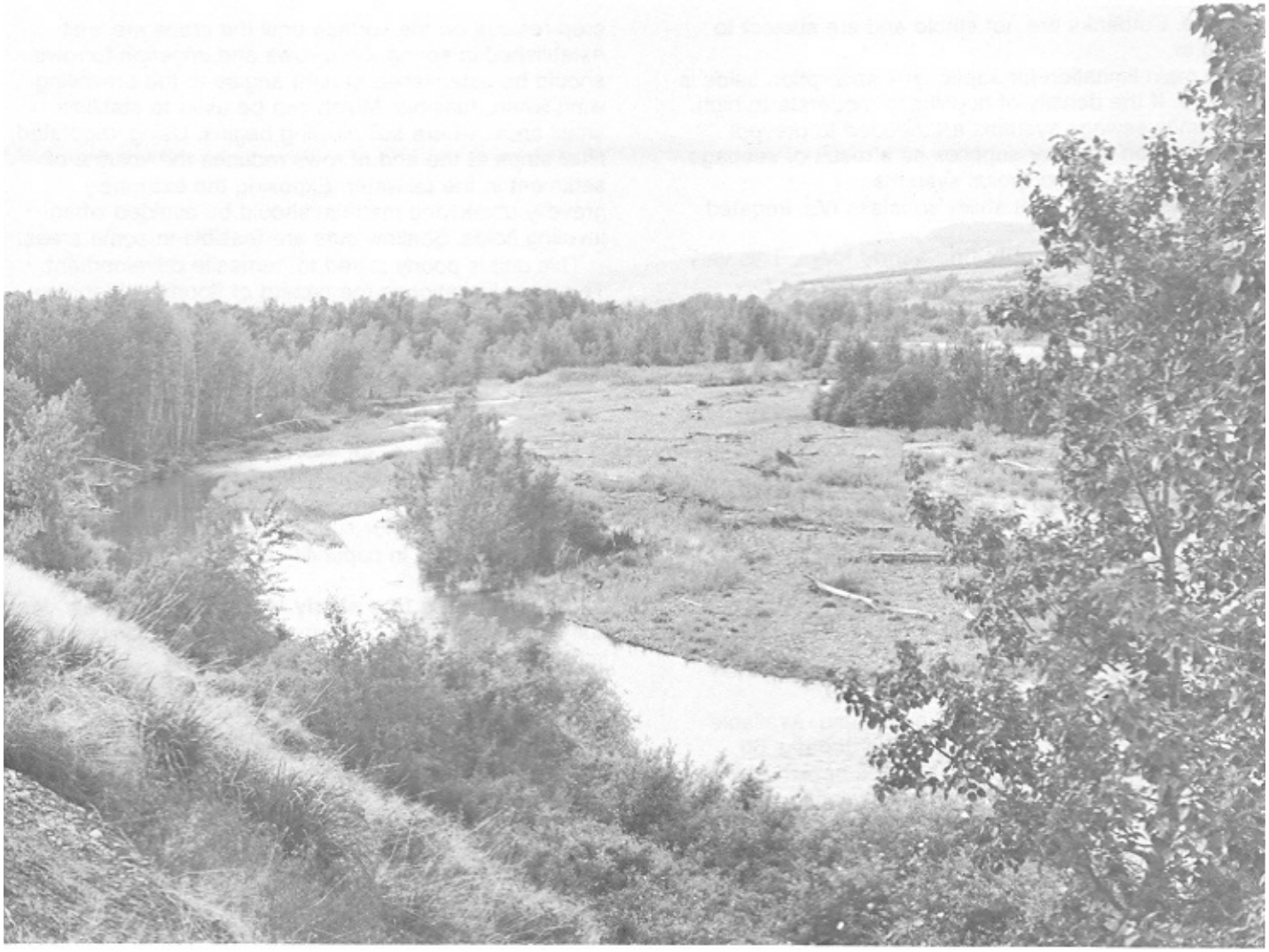

Figure 8.-Weirman sandy loam, channeled, with riparian vegetation.

runs short. Use of sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce the risk of soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation reduces erosion. The soil should be protected from erosion by maintaining crop residue on the surface until crops are well established in spring. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Vegetative barriers and windbreaks also reduce soil blowing. Mulching helps to stabilize small areas where soil blowing begins. Using vegetated filter strips at the end of rows reduces the volume of sediment in the tailwater. Exposing the extremely gravelly underlying material should be avoided when leveling fields. Shallow cuts are feasible in selected areas.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Flooding can be controlled by use of dikes and channels that have outlets to bypass floodwater. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as

possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVe, irrigated.

183-Weirman gravelly fine sandy loam. This very deep, somewhat excessively drained soil is on low terraces and flood plains. It formed in mixed alluvium. Slope is 0 to 5 percent. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 14 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown gravelly fine sandy loam about 8 inches thick. The upper part of the underlying material is stratified, grayish brown and light brownish gray loamy fine sand about 13 inches thick, and the lower part to a depth of 60 inches or more is grayish brown extremely gravelly sand. In some areas the surface layer is sandy loam or fine sandy loam, or it is gravelly, cobbly, or stony.

Included in this unit are areas of Zillah, Logy, and Yakima soils.

Permeability of this Weirman soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. The soil is subject to rare periods of flooding.

The unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, and grapes. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are low available water capacity and the hazard of soil blowing. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short and establishing them on the contour or across the slope. Use of sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation and using vegetative barriers and windbreaks also reduce soil blowing. The soil should be protected from soil blowing by maintaining crop residue on the surface until the crops are well established in spring. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Mulch can be used to stabilize small areas where soil blowing begins. Using vegetated filter strips at the end of rows reduces the volume of sediment in the tailwater. Exposing the extremely gravelly underlying material should be avoided when leveling fields. Shallow cuts are feasible in some areas.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Flooding can be controlled by the use of dikes and channels that have outlets to bypass floodwater. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IVe, irrigated.

184-Weirman fine sandy loam, wet. This very deep soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 2 percent. The native vegetation is mainly water-tolerant sedges and rushes. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 14 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The upper part of the underlying material is stratified, grayish brown and light brownish gray loamy fine sand about 13 inches thick, and the lower part to a depth of 60 inches or more is grayish brown gravelly sand. In some areas the surface layer is silt loam or is gravelly or cobbly.

Included in this unit are areas of Zillah, Logy, and Yakima soils.

Permeability of this Weirman soil is rapid. Available water capacity is low. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 24 inches from April to November. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. The soil is subject to occasional periods of flooding in spring.

This unit is used for irrigated crops and as homesites. Where the soil in the unit is drained and protected from flooding, the main irrigated crops are corn, grain, and peas. Grasses and legumes are grown for hay and pasture.

The main limitations for irrigated crops are wetness, the hazard of soil blowing, and low available water capacity. Deep-rooted crops are suited to areas where the natural drainage is adequate or where a drainage system has been installed. Dikes can be used to divert floodwater.

Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Proper timing of minimum tillage reduces compaction. Return of crop residue to the soil helps to maintain or improve the organic matter content, helps to maintain tilth, and reduces soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation and using vegetative barriers and windbreaks also reduce soil blowing. The soil should be protected from soil blowing by maintaining crop residue on the surface until the crops are well established in spring. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Mulch can be used to stabilize small areas where soil blowing begins.

Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Exposing the extremely gravelly substratum should be avoided when leveling fields. Shallow cuts are feasible in some areas.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and wetness. Flooding can be controlled by use of dikes and channels to bypass floodwater. Deep drainage reduces the problem of wetness. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitations for septic tank absorption fields are the hazard of flooding, wetness, and seepage. Wetness increases the possibility of failure of septic tank absorption fields. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IVw, irrigated.

185-Wenas silt loam. This very deep, artificially drained soil is on flood plains. It formed in alluvium. Slope is 0 to 2 percent. The native vegetation is mainly water-tolerant grasses and forbs. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is dark gray silt loam about 8 inches thick. The upper part of the subsoil is dark grayish brown silt loam about 20 inches thick, and the lower part is gleyed, gray silty clay loam about 9 inches thick. The upper part of the substratum is gleyed, grayish brown loam about 10 inches thick, and the lower part to a depth of 60 inches or more is gleyed, light brownish gray loamy sand and gravelly loamy sand. In some areas the soil is calcareous throughout the profile.

Included in this unit are about 5 percent Esquatzel soils, 5 percent Kittitas soils, and 5 percent Toppenish soils. Also included are areas of soils that are underlain by a hardpan at a depth of 20 to 40 inches and areas of Wenas soils that are not artificially drained.

Permeability of this Wenas soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 42 inches from June to November. Runoff is very slow, and the hazard of water erosion is slight. The soil is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Where the soil in this unit is drained, the main irrigated crops are grain, hops, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is wetness. Deep-rooted crops are suited to areas where a drainage system has been installed and is maintained. Dikes can be used to divert floodwater. Unless a drainage system is maintained, the soil in this unit has a seasonal high water table during the irrigation season.

Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Proper timing of minimum tillage and return of crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and wetness. Flooding can be controlled by use of dikes and channels that have outlets to bypass floodwater. Deep drainage reduces the problem of wetness. Dustiness can be a problem during construction on large building sites;

therefore, these sites should be disturbed as little as possible.

The main limitations for septic tank absorption fields are wetness and moderately slow permeability, which increase the possibility of failure of the absorption fields. Use of long absorption lines and sandy backfill for the trench helps to compensate for the moderately slow permeability.

This map unit is in capability subclass IIw, irrigated.

186-Willis fine sandy loam, 2 to 5 percent slopes. This well drained soil is on uplands. It is moderately deep over a hardpan. It formed in loess. The native vegetation is mainly grasses and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is grayish brown and brown fine sandy loam about 6 inches thick. The subsoil is brown silt loam about 16 inches thick. The substratum is brown and pale brown silt loam about 12 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan generally is underlain by basalt, but in some areas it is underlain by gravel and sand or alternate layers of loess and hardpan. In some areas the surface layer is silt loam, and in some areas hardpan fragments are scattered throughout the profile and on the surface.

Included in this unit are areas of Harwood, Burke, Wiehl, Ritzville, Mikkalo, and Moxee soils and areas of Willis soils that have slopes of less than 2 percent.

Permeability of this Willis soil is moderate above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is high.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, grapes, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the hazard of soil blowing and depth to the hardpan. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation and using vegetative barriers and windbreaks also reduce soil blowing. The soil should be protected from soil blowing by maintaining crop residue on the surface until the crops are well established in spring. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Mulching helps to stabilize small areas where soil blowing begins. Growing mint in meadows rather than in rows greatly reduces erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitation for use as homesites is the moderate depth to the hardpan. The pan hinders excavation. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the moderate depth to the hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIe, irrigated.

187-Willis silt loam, 2 to 5 percent slopes. This well drained soil is on uplands. It is moderately deep over a hardpan. It formed in loess. The native vegetation is mainly grasses and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is grayish brown and brown silt loam about 6 inches thick. The subsoil is brown silt loam about 16 inches thick. The substratum is brown and pale brown silt loam about 12 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan generally is underlain by basalt, but in some areas it is underlain by sand and gravel or alternate layers of loess and hardpan. In some areas the surface layer is fine sandy loam, and in some areas hardpan fragments are throughout the profile and on the surface.

Included in this unit are small areas of Harwood, Burke, Wiehl, Ritzville, Mikkalo, and Moxee soils and areas of Willis soils that have slopes of less than 2 percent.

Permeability of this Willis soil is moderate above the hardpan and very slow through it. Available water

capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated and nonirrigated crops, as rangeland, for wildlife habitat, and as homesites. The main irrigated crops are corn, grain, grapes, hops, mint, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the depth to the hardpan and the hazard of water erosion. Furrow, corrugation, drip, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used generally depends on the kind of crop grown. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. The risk of erosion can be minimized by keeping runs short. Use of sprinkler or drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and prevent excessive ditch erosion.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Growing mint in meadows rather than in rows greatly reduces erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. Deep cuts should be avoided when leveling fields. Shallow cuts are feasible in some areas.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grasses.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fail using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for use as homesites is the moderate depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, moderate depth to the hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclasses IIe, irrigated, and IIIe, nonirrigated.

188-Willis silt loam, 5 to 8 percent slopes. This well drained soil is on uplands. It is moderately deep over a hardpan. It formed in loess. The native vegetation is mainly grasses and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is grayish brown and brown silt loam about 6 inches thick. The subsoil is brown silt loam about 16 inches thick. The substratum is brown and pale brown silt loam about 12 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan generally is underlain by basalt, but in some areas it is underlain by sand and gravel or alternate layers of loess and hardpan. In some areas the surface layer is fine sandy loam, and in some areas hardpan fragments are throughout the profile and on the surface.

Included in this unit are small areas of Harwood, Burke, Wiehl, Ritzville, Mikkalo, and Moxee soils.

Permeability of this Willis soil is moderate above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for irrigated and nonirrigated crops, rangeland, wildlife habitat, and homesites. The main irrigated crops are corn, grain, grapes, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are the depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. Use of these irrigation systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage andl retu$_{rn}$ of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, improve the water infiltration rate, and reduce erosion. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Cover crops reduce erosion in orchards and vineyards.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grasses.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitation for use as homesites is the moderate depth to the hardpan, which hinders excavation. Dustiness can be a problem during construction on large sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIIe, irrigated.

189-Willis silt loam, 8 to 15 percent slopes. This well drained soil is on uplands. It is moderately deep over a hardpan. It formed in loess. The native vegetation is mainly grasses and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typically, the surface layer is grayish brown and brown silt loam about 6 inches thick. The subsoil is brown silt loam about 16 inches thick. The substratum is brown and pale brown silt loam about 12 inches thick. A lime- and silica-cemented hardpan is at a depth of about 34 inches. Depth to the hardpan ranges from 20 to 40 inches. The hardpan commonly is underlain by basalt, but in some areas it is underlain by sand and gravel or alternate layers of loess and hardpan. In some areas hardpan fragments are throughout the profile and on the surface.

Included in this unit are areas of Harwood, Burke, Wiehl, Ritzville, Mikkalo, and Moxee soils.

Permeability of this Willis soil is moderate above the hardpan and very slow through it. Available water capacity is moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for irrigated and nonirrigated crops, as rangeland, for wildlife habitat, and as homesites. The main irrigated crops are grain, corn, and grapes. Grass and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are depth to the hardpan, steepness of slope, and the hazard of water erosion. Sprinkler and drip irrigation systems are suited to the soil in this unit. Use of these systems permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Cultivation prior to irrigation improves the water infiltration rate; however, the fine soil particles dislodged during cultivation are highly susceptible to water erosion. This makes the initial period of irrigation extremely critical. The water application rate should be reduced accordingly to help control runoff, erosion, and the production of sediment. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, improve the water infiltration rate, and reduce erosion. Tillage should be across the slope or on the contour. Using a cropping system that includes close-growing, high-residue crops in

the rotation and maintaining crop residue on the surface reduce water erosion. Annual or perennial cover crops reduce erosion in orchards and vineyards.

The main limitations for nonirrigated crops are low annual precipitation and the hazard of water erosion. Because precipitation is not sufficient for annual cropping, a cropping system that includes winter wheat and summer fallow is most suitable. Erosion can be reduced by seeding fall grain early, stubble mulching, using terraces and diversions, and stripcropping. Seeding on the contour or across the slope slows runoff and reduces erosion when the snow melts rapidly while the soil is still frozen. Drop structures are needed in places to control the flow of runoff in waterways. Waterways should be shaped and seeded to perennial grass.

The potential native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. If the range is overgrazed, the proportion of preferred forage plants such as bluebunch wheatgrass decreases and the proportion of less preferred forage plants such as big sagebrush and rabbitbrush increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as chaining, railing, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. This unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is poorly suited to homesite development. The main limitations for use as homesites is the moderate depth to the hardpan and steepness of slope. The hardpan hinders excavation. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible.

If this unit is used for septic tank absorption fields, the moderate depth to the hardpan limits the capacity of the absorption fields. Use of long absorption lines helps to compensate for this limitation. Slope can cause lateral seepage and surfacing of the effluent in downslope areas. Absorption lines should be placed on the contour.

This map unit is in capability subclasses IVe, irrigated and IIIe, nonirrigated.

190-Yakima silt loam. This very deep, well drained soil is on flood plains. It formed in alluvium. Slope is 0 to 2 percent. The native vegetation is mainly grasses and shrubs. Elevation is 700 to 1,200 feet. The average annual precipitation is 9 to 14 inches, the average annual air temperature is about 54 degrees F, and the average frost-free season is 120 to 170 days.

Typically, the upper part of the surface layer is grayish brown silt loam about 13 inches thick. The lower part is dark grayish brown sandy loam and brown gravelly very fine sandy loam about 14 inches thick. The upper part of the underlying material is brown gravelly very fine sandy loam about 3 inches thick, and the lower part to a depth of 60 inches or more is dark grayish brown extremely gravelly coarse sand. In some areas the surface layer is gravelly or stony.

Included in this unit are areas of Logy, Esquatzel, and Weirman soils.

Permeability of this Yakima soil is moderate in the surface layer and very rapid in the underlying material. Available water capacity is moderately high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. This unit is subject to occasional periods of flooding in spring.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. The main irrigated crops are asparagus, grain, grapes, hops, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is the hazard of flooding. Dikes are effective in diverting floodwater. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should also be adjusted to the available water capacity and the crop needs. Pipe, ditch lining, or drop structures should be installed in irrigation ditches to facilitate irrigation and reduce ditch erosion.

Proper timing of minimum tillage and return of crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. A plowpan develops in this soil; however, it can be broken by chiseling or subsoiling when the soil is dry. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater. When leveling fields, care should be taken to avoid cutting into the very gravelly part of the substratum. Shallow cuts are feasible in some areas.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding. Flooding can be controlled by use of dikes and channels that have outlets to bypass floodwater. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitations for septic tank absorption fields are the hazard of flooding and seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies

as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIw, irrigated.

191-Zillah sandy loam. This very deep, artificially drained soil is on flood plains. It formed in recent alluvium. Slope is 0 to 2 percent. The native vegetation is mainly water-tolerant trees, sedges, and forbs. Elevation is 600 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The upper part of the underlying material is gray silt loam about 30 inches thick, and the lower part to a depth of 60 inches or more is gray loamy sand. In some areas the surface layer is silt loam, and in some areas the part of the underlying material below a depth of 40 inches is very gravelly.

Included in this unit are areas of Ashue, Esquatzel, Toppenish, and Weirman soils. Also included are areas of Zillah soils that have not been artificially drained and areas of salt- and alkali-affected soils.

Permeability of this Zillah soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 48 inches from April to November. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. The soil is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Where the unit is drained and protected from flooding, the main irrigated crops are asparagus, corn, grain, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitations for irrigated crops are wetness and the hazard of soil blowing. Dikes can be used to divert floodwater. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. Use of sprinkler irrigation permits the even, controlled application of water and reduces runoff. To avoid loss of water and leaching of plant nutrients from overirrigation, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.

Use of minimum tillage and return of crop residue to the soil help to maintain or improve the organic matter content, help to maintain tilth, and reduce soil blowing. Using a cropping system that includes close-growing, high-residue crops in the rotation and using vegetative barriers and windbreaks also reduce soil blowing. The soil should be protected from soil blowing by maintaining crop residue on the surface until the crops are well established in spring. Crop rows and irrigation furrows should be established at right angles to the prevailing wind where feasible. Mulch can be used to stabilize small areas where soil blowing begins.

This unit is poorly suited to homesite development. The main limitations are wetness and the hazard of flooding. Flooding can be controlled by use of dikes and channels that have outlets to bypass floodwater. Deep drainage reduces the problem of wetness. Soil blowing can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic tank absorption fields is wetness, which increases the possibility of failure of septic tank absorption fields. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IIw.

192-Zillah silt loam. This very deep, artificially drained soil is on flood plains. It formed in recent alluvium. Slope is 0 to 2 percent. The native vegetation is mainly water-tolerant trees, sedges, and forbs. Elevation is 600 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown silt loam about 12 inches thick. The upper part of the underlying material is gray silt loam about 30 inches thick, and the lower part to a depth of 60 inches or more is gray loamy sand. In some areas the surface layer is sandy loam, and in some areas the part of the underlying material below a depth of 40 inches is very gravelly.

Included in this unit are areas of Ashue, Esquatzel, Toppenish, and Weirman soils. Also included are areas of soils that have not been artificially drained and areas of salt- and alkali-affected soils.

Permeability of this Zillah soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 48 inches during the months of April to November. Runoff is very slow, and the hazard of water erosion is slight. The soil is subject to rare periods of flooding.

This unit is used for irrigated crops, for wildlife habitat, and as homesites. Where the unit is drained and protected from flooding, the main irrigated crops are asparagus, corn, grain, grapes, and peas. Grasses and legumes are grown for hay, pasture, and seed.

The main limitation for irrigated crops is wetness. Dikes can be used to divert floodwater. Furrow, corrugation, and sprinkler irrigation systems are suited to the soil in this unit. The type of system used depends on the kind of crop grown. If surface irrigation systems are used, the risk of erosion can be minimized by keeping runs short. Use of sprinkler and drip irrigation permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid loss of water and leaching of plant nutrients from overirrigation,

applications of irrigation water should also be adjusted to the available water capacity and the crop needs.

Proper timing of minimum tillage and return of crop residue to the soil reduce compaction, help to maintain or improve the organic matter content, help to maintain tilth, and improve the water infiltration rate. Using a cropping system that includes close-growing, high-residue crops in the rotation and maintaining crop residue on the surface reduce water erosion. Using vegetated filter strips at the end of rows or using sediment ponds, or both, reduces the volume of sediment in the tailwater.

This unit is poorly suited to homesite development. The main limitations are wetness and the hazard of flooding. Deep drainage reduces wetness. Flooding can be controlled by use of dikes and channels that have outlets to bypass floodwater. Dustiness can be a problem during construction on large building sites; therefore, these sites should be disturbed as little as possible. Cutbanks are not stable and are subject to caving in.

The main limitation for septic absorption fields is wetness, which increases the possibility of failure of absorption fields. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IIw, irrigated.

193-Zillah silt loam, channeled. This very deep, somewhat poorly drained soil is in ponded areas on flood plains. The soil is dissected by intermittent and perennial streams. It formed in recent alluvium. Slope is 0 to 2 percent. The native vegetation is mainly water-tolerant trees, sedges, and forbs. Elevation is 600 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typically, the surface layer is grayish brown silt loam about 12 inches thick. The upper part of the underlying material is gray silt loam about 30 inches thick, and the lower part to a depth of 60 inches or more is gray loamy sand. In some areas the surface layer is cobbly or stony, in some areas the soil is cobbly or stony throughout, and in some areas the part of the underlying material below a depth of 40 inches is very gravelly.

Included in this unit are areas of Ashue, Esquatzel, and Weirman soils.

Permeability of this Zillah soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to 12 inches from April to November. Runoff is very slow. The soil is subject to frequent periods of flooding in spring.

This unit is used as rangeland and for wildlife habitat. The potential native vegetation is mainly basin wildrye, tufted hairgrass, sedges, and willows. The main limitation for the production of forage is wetness. If the range is overgrazed, the proportion of preferred forage plants such as basin wildrye and bluebunch wheatgrass decreases and the proportion of less preferred forage plants increases. Areas that are heavily infested with undesirable vegetation can be improved by such methods as railing, chaining, beating, plowing, chemical treatment, and prescribed burning. Range seeding is a suitable practice if the range vegetation is in poor condition. The soil in this unit should be seeded in fall using a drill. Adapted grasses and legumes should be seeded.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential. Water tanks are a more effective and reliable means of storing water for livestock.

This map unit is in capability subclass VIw, nonirrigated.

prime farmland

Prime farmland, as defined by the United States Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It must either be used for producing food or fiber or be available for these uses. It has the soil quality, length of growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is managed properly. Prime farmland produces the highest yields with minimal energy and economic resources, and farming it results in the least disturbance of the environment.

Prime farmland commonly has an adequate and dependable supply of moisture from precipitation or irrigation. It also has a favorable temperature and length of growing season and an acceptable level of acidity or alkalinity. It has few if any rock fragments and is permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods and is not flooded during the growing season. The slope is mainly 0 to 5 percent. Soils that are limited by a high water table, a hazard of flooding, or low rainfall may qualify for prime farmland if these limitations are overcome by practices such as drainage, flood control, or irrigation. Onsite investigation is needed to determine the extent of these limitations.

About 136,000 acres, or nearly 15 percent, of the survey area meets the soil requirements for prime farmland if irrigated. About 60 percent of this is in general soil map unit 4, in the east-central part of the area, and minor amounts are in map units 1, 7, 8, and 9. In addition, about 37,000 acres, or nearly 4 percent, of the survey area meets the requirements for prime farmland if the soils are adequately irrigated, adequately drained, and reclaimed. These soils are primarily in map units 4 and 8, in the east-central and southern parts of the area.

Crops grown on the prime farmland in this survey area are mainly corn, hops, asparagus, mint, and tree fruit such as apples, cherries, peaches, and pears. These crops support a sizeable light industry that includes processing, storing, and shipping the crops and marketing farm supplies.

A recent trend in land use in some parts of the area has been to convert areas of prime farmland to industrial and urban areas. The loss of prime farmland to these and other uses has made it necessary to farm areas that generally are more erodible, droughty, and difficult to cultivate and are less productive.

The following map units meet the requirements for prime farmland if irrigated. The practices needed in addition to irrigation to overcome the limitations, if any, are shown in parentheses after the map unit name. The extent of each map unit is given in table 4, the location is given on the detailed soil maps in the back of this publication, and the soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

2 Ashue loam
4 Bickleton silt loam, 0 to 5 percent slopes
10 Burke silt loam, 2 to 5 percent slopes
18 Cleman very fine sandy loam, 0 to 2 percent slopes
19 Cleman very fine sandy loam, 2 to 5 percent slopes
24 Cowiche loam, 2 to 5 percent slopes
32 Esquatzel silt loam, 0 to 2 percent slopes
33 Esquatzel silt loam, 2 to 5 percent slopes
46 Harwood loam, 2 to 5 percent slopes
50 Harwood-Burke-Wiehl silt loams, 2 to 5 percent slopes
66 Kittitas silt loam (if artificially drained and reclaimed)
79 Mikkalo silt loam, 0 to 5 percent slopes
86 Naches loam
91 Outlook fine sandy loam (if artificially drained and reclaimed)
92 Outlook silt loam (if artificially drained and reclaimed)
97 Renslow silt loam, basalt substratum, 0 to 5 percent slopes
99 Ritzville silt loam, 2 to 5 percent slopes
104 Ritzville silt loam, basalt substratum, 0 to 5 percent slopes
124 Scooteney silt loam, 0 to 2 percent slopes
125 Scooteney silt loam, 2 to 5 percent slopes
128 Selah silt loam, 2 to 5 percent slopes
132 Shano silt loam, 2 to 5 percent slopes
139 Sinloc silt loam, 0 to 2 percent slopes (if artificially drained and reclaimed)
140 Sinloc silt loam, 2 to 5 percent slopes (if artificially drained and reclaimed)
156 Tieton fine sandy loam, 2 to 5 percent slopes
157 Tieton loam, 0 to 2 percent slopes
158 Tieton loam, 2 to 5 percent slopes
163 Toppenish silt loam
168 Umapine silt loam, 0 to 5 percent slopes (if artificially drained and reclaimed)
169 Umapine silt loam, drained, 0 to 2 percent slopes
170 Umapine silt loam, drained, 2 to 5 percent slopes
172 Warden fine sandy loam, 0 to 2 percent slopes
173 Warden fine sandy loam, 2 to 5 percent slopes
176 Warden silt loam, 0 to 2 percent slopes
177 Warden silt loam, 2 to 5 percent slopes
185 Wenas silt loam
186 Willis fine sandy loam, 2 to 5 percent slopes
187 Willis silt loam, 2 to 5 percent slopes
190 Yakima silt loam
192 Zillah silt loam

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, slope, or other soil features can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Tom Reedy, soil scientist, Soil Conservation Service, prepared this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Each area of cropland is a unique combination of soils, slopes, elevation, climate, and other characteristics. Management should consist of a system that recognizes these characteristics. The objective of a cropland management system is to maintain or improve the quality of the environment; to maintain or improve crop production while conserving energy resources; and to protect the soil from erosion.

Management practices that enhance the environment may include developing watering facilities, planting hedgerows, leaving some standing grain, or establishing permanent cover for wildlife in odd areas. Other environmental concerns such as properly using pesticides, properly disposing of empty containers, trapping sediment in debris basins, and properly disposing of animal waste should also be considered.

Management practices that protect the soil from erosion also may provide additional environmental, production, or energy benefits. Erosion control practices include using an adapted crop rotation that may include cover crops, green manure crops, or grasses and legumes in the rotation; using minimum tillage; using crop residue; stubble mulching; seeding early in fall; divided-slope farming; fall chiseling; and using terraces, field windbreaks, and grassed waterways.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 268,880 acres of this survey area is irrigated cropland. A wide variety of crops are grown under irrigation, including apples, cherries, peaches, apricots, mint, hops, asparagus, sweet corn, corn for silage, grapes, hay and pasture, and wheat. Production of crops such as irrigated corn, squash, melons, wheat, and potatoes fluctuates, depending on the market value of the major crops and on the crop rotation system used. About 64,000 acres of the area is nonirrigated cropland. The main nonirrigated crop is winter wheat grown in a wheat-summer fallow cropping system.

The deep, well drained soils in the area that warm up early in spring and have a relatively long growing season-more than 135 frost-free days-are well suited

to irrigated orchard and vegetable crops. These soils include Esquatzel and Cleman soils on flood plains; Cowiche, Ritzville, Shano, and Tieton soils on uplands; and Scooteney and Warden soils on terraces. These soils, as well as Renslow and Taneum soils, are also well suited to nonirrigated small grain.

Most of the well drained soils in irrigated areas are suited to orchard and vegetable crops. Frost control is needed in areas of these soils where frosts occur late in spring as a result of poor air drainage. Suitable practices for frost control include use of orchard heaters, wind machines, and over-tree or under-tree sprinklers (5). In these areas it is important, especially when replanting, to consider growing fruit trees that develop later in spring and thus are less subject to frost damage. Whenever possible, trees should be planted up and down the slope to allow air to drain freely.

Most of the crops grown in the survey area respond well to nitrogen, phosphorus, and potassium. Ammonium nitrate, ammonium sulfate, and urea fertilizers commonly are used. Urea fertilizer is most popular and is least expensive per unit of nitrogen applied. Periodic applications of lime are needed because of the acidifying effect of ammonium fertilizer. Where leaching has occurred, applications of boron may be needed. Some areas are deficient in zinc, especially if they have been leveled. Some areas are low in content of sulfur. Some foliar applications of micronutrients are used in orchards.

The soils in the survey area range from slightly acid to very strongly alkaline. Soils that are strongly alkaline or very strongly alkaline, such as the somewhat poorly drained Fiander, Kittitas, Outlook, Sinloc, and Umapine soils and the poorly drained Wanser soils, are high in content of exchangeable sodium. These soils should be leached with elemental sulfur or sulfuric acid if they have an inherently high content of free lime. Gypsum is needed if the content of free lime is not adequate (22). Because these soils have a water table at a relatively shallow depth, provisions for improved drainage are needed before the soils are leached.

For all soils in the survey area, the amount of lime, gypsum, fertilizer, and other amendments applied should be based on soil tests, on the needs of the crop, and on the expected yields. The local office of the Cooperative Extension Service can help to determine the kind and amount of amendments to apply.

About 2 percent of the soils in the survey area are somewhat poorly drained and have a sufficiently high water table that drainage is needed for maximum crop production. Many of these wet areas provide critical habitat for wildlife, because permanent vegetation has been removed by intensive farming in many parts of the survey area. Wet areas also provide ground water recharge, serve as sinks for sediment and nutrients, store floodwater temporarily, and improve the esthetic value of the landscape.

Subsurface drainage systems should be designed according to soil permeability, with narrower spacing where permeability is less. The amount of water to be drained should determine the size of drain pipe and the gradient. All drainage systems should be discharged to an acceptable drainage course that will not further contribute to surface water pollution. The wet soils may need amendments to facilitate leaching of excessive sodium.

Generally, soils relatively high in organic matter content have good tilth. As tilth increases, soil erosion and surface crusting decrease and the water intake rate increases. Therefore, it is important to have crops in the cropping system that will maintain or improve the organic matter content. This can be done by incorporating as much residue as possible into the soil and by rotating high residue crops such as grain, grasses, legumes, and corn with low residue row crops. To facilitate the decomposition of residue to organic matter, adequate nitrogen fertilizer is needed.

Irrigation water management is the major resource conservation concern in irrigated areas. If irrigation water is not properly applied, soil erosion results. Erosion is a concern because the surface layer, which is the most fertile layer in the soil profile and contains most of the organic matter and available plant nutrients, is the first to be eroded away. With loss of organic matter, the structure of the soil deteriorates, available water capacity and the water intake rate decrease, and general tilth is lost. Thus, soil erosion reduces the productivity of the soil and eventually results in pollution of streams by deposition of sediment, nutrients, and pesticides.

If irrigation water is not properly conserved and the rate of application is excessive, soil erosion is increased in most areas. Wasteful use of water reduces streamflow of the Yakima River and compounds water pollution problems in most streams in the area. Cropping systems that keep a plant cover and residue on the soil during critical periods reduce soil erosion.

Proper irrigation water management and proper use of agronomic practices minimize the hazard of erosion. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid loss of water and leaching of plant nutrients and to minimize erosion. Rotating close-growing crops such as grass and alfalfa in the cropping system on sloping soils reduces erosion by protecting the soil surface and increasing the water intake rate. Use of minimum tillage and high residue crops such as wheat and corn reduces the amount of the surface exposed, minimizes sealing of the surface, slows runoff, and reduces erosion. Growing cover crops in vineyards and orchards during the irrigation season and growing mint in meadows also reduce erosion.

In dryland areas soil blowing and water erosion are reduced if fall grain is seeded early, nitrogen is applied, stubble mulch tillage is used, fields are stripcropped, and

tillage is on the contour or across the slope. Chiseling or subsoiling the stubble fields in fall on the contour or across the slope slows runoff and increases the water intake. Terraces and diversions, which are most practical on deep and moderately deep soils, reduce the length of slopes and thereby reduce runoff and erosion. The shallow Gorst, Lickskillet, Moxee, Scoon, and Starbuck soils are not suited to dryland cultivation and should be seeded to permanent grass.

Soil blowing is a hazard on the sandy Quincy and Hezel soils. If irrigated, these soils should not be left barren during periods when the soils are susceptible to erosion. Use of winter cover crops, strip tillage, and crop residue is needed to control soil blowing in spring. Retaining crop residue on the surface or using straw, manure, and other material as mulch reduces soil blowing, helps to maintain or improve organic matter content, and conserves moisture.

Because of the rapid permeability of the Quincy and Hezel soils, the high streamflow needed for water to reach the full length of the furrows causes excessive erosion. Therefore, the soils are not suited to surface irrigation systems but are suited to sprinkler, trickle, or drip systems. Because of the droughtiness of these soils, frequent light applications of water are needed. Unless irrigated, these soils are poorly suited to cultivation.

Compaction and breakdown of soil structure caused by excessive tillage and continuous use of heavy equipment are common on the silt loams and loams in the area. These also reduce the water intake rate and increase the risk of erosion. Soil compaction can be reduced by use of minimum tillage, proper timing of tillage in relation to moisture content, close-growing crops, and crop residue. Tillage pans may be broken up by subsoiling or chiseling when the soil is dry. Use of minimum tillage and crop residue also helps to maintain soil structure.

Furrow, corrugation, sprinkler, or drip irrigation systems are used in the survey area. Sprinkler and drip irrigation systems are suited to all the soils in the survey area. These systems permit an even, controlled application of irrigation water and, if managed properly, reduce the risk of erosion and leaching of plant nutrients. Furrow and corrugation systems are used on most soils that have slopes of less than 5 percent. Use of surface systems on the shallow Gorst, Moxee, Scoon, and Starbuck soils is not practical regardless of the slope, because the hazard of eroding the furrows is too high. These soils are suited to sprinkler, drip, and trickle systems only. Using a cropping system that provides continuous plant cover, such as hay and pasture, or growing perennial cover crops in orchards reduces erosion on these soils.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. For those soils used as nonirrigated cropland and where a summer-fallow cropping system is used, the yields represent the year that the soils are cropped.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small or because yield data were not available. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class Vi soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, e, w, s, or c, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

By Richard A. Pudney, range conservationist, Soil Conservation Service.

Approximately 48 percent, or about 425,456 acres, of the Yakima County Area is rangeland. Cow-calf-steer operations are dominant in the area. Although individual operations vary, the livestock commonly are grazed at lower elevations in spring and then are moved to the foothills early in summer. Later, the livestock are transported to the mountainous areas, where they remain in summer and early in fall. Then they are returned to stubble fields and feedlots for the winter.

Many livestock operations are run in combination with nonirrigated and irrigated farming. The farm and livestock operations vary from growing crops to provide feed for livestock in winter to farming operations in which livestock are used to graze odd areas, stubble fields or other crop aftermath.

Forage production is influenced by the amount of precipitation, length of the growing season, and the available water capacity of the soil. Areas at lower elevations receive less precipitation and are fairly low in forage production. As elevation increases, production also increases unless it is limited by a short growing season. The available water capacity varies at both low and high elevations. Shallow soils have less available water capacity and produce less forage than do deep soils, which generally have a high available water capacity.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland are listed. Explanation of the column headings in table 6 follows.

A range site is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation-the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil-is listed by common name. Under *composition,* the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of water erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The basic soil and plant resources in the survey area can be maintained or improved through proper management. Among the range management practices important for all rangeland in the area are proper grazing use and planned grazing systems, which include deferred grazing, proper season of use, and good distribution of grazing. Distribution of grazing can be accomplished by proper placement of watering facilities and salt and by fencing where needed. The suitability of range improvement practices such as brush management, range seeding, and use of pipelines depends on the characteristics of a given site.

Livestock graze selectively; they seek out the palatable and nutritious plants and graze them intensively. Without proper grazing management, these preferred plants are depleted. As the preferred plants decrease, less palatable plants increase. If poor grazing management is continued, the less palatable plants are depleted by livestock and unpalatable grasses, weeds, shrubs, and annual plants invade. Rangeland that is dominated by these plants produces only a fraction of the usable forage it is capable of producing and supports far fewer livestock than it potentially can support.

Sound range management consists of practices such as balancing the requirements of livestock and wildlife with the forage available, proper grazing use and distribution, and periodically resting the preferred and less palatable vegetation from grazing during the growing season.

In determining how many animals an area can support, it is essential to know how much of the area will be used by the animals. Stock water is often a key factor. Livestock in the more nearly level areas generally make good use of vegetation that is as much as 1 mile from water, but in extremely steep areas they may not travel more than one-fourth of a mile from water. Development of stock water in underused areas improves the use of the forage in these areas and reduces use in overgrazed areas. Placing salt blocks in undergrazed areas also helps to entice livestock away from overused areas and to improve use in isolated areas. Cross fencing is another good way to improve livestock distribution, but it should be used in combination with stock water developments and other management practices.

Periodic rest from grazing during the growing season allows the preferred and less palatable vegetation to build up its root reserves and to improve its vigor and production. Various deferred-rotation grazing systems can be developed to insure that each pasture gets periodic rest from grazing during the growing season. Rotation grazing systems can also be tailored to meet the needs of any ranching operation.

Proper grazing use is essential in any grazing operation. Enough of the plant must be left following grazing to allow the plant to continue to manufacture its own food. This process, called photosynthesis, depends on the leaves of the plant to absorb carbon dioxide, an essential element in the process. When all leaves are removed by close grazing, the plant has to use the food reserves stored in its root system to continue to grow and survive. If a plant is continuously overgrazed, its store of food in the root system will eventually run out and the plant will die. Proper grazing use insures that the plants can continue to manufacture food. Good management leads to productive, healthy forage plants that have root systems strong enough to survive through unfavorable years.

woodland management and productivity

By Ronald A. Peyton, forester, Soil Conservation Service.

About 133,800 acres, or 15 percent, of the survey area is forested. Most of this land is in privately owned commercial holdings. The area has 10 distinct forest cover types (20). The major forest cover types that have commercial value are interior ponderosa pine, interior Douglas-fir, grand fir-larch-Douglas-fir, and ponderosa pine-larch-Douglas-fir. The minor forest cover types include Englemann spruce-subalpine fir, lodgepole pine, whitebark pine, western larch-Douglas-fir, black cottonwood-willow, and Oregon white oak.

Moisture and topography generally dictate the character of the forests in the survey area (11). Along the eastern fringe of the forest land, timber stands are scattered and occur mainly as narrow bands on canyon bottoms and along canyonsides. These meandering strips of timber merge into sparse stands of ponderosa pine and Oregon white oak, which are adjacent to denser stands of mixed species in the higher lying, more moist areas. As a result, a large portion of the timber is along a band 30 miles wide that is east of the crest of the Cascade Range.

Forest management in the survey area ranges from little if any management to intensive cultural practices such as fertilization and precommercial and commercial thinning on a preset time schedule. Present stands vary widely in species, age, and size distribution. Selective harvesting of old growth, high-quality ponderosa pine and Douglas-fir has contributed to this heterogeneous nature of the stands. In addition, the regular occurrence of wildfire has produced numerous areas that are densely stocked with lodgepole pine and western larch. Many of the lodgepole pine stands in the area are overstocked, and reduced yields may be a concern in these areas unless some thinning is done.

Many kinds of insects and disease attack forest trees in this area (6,12). The damage they do varies from year to year (8). Normally, losses are confined to individual trees or to scattered stands; however, insect populations increase occasionally, and large numbers of trees are damaged or killed.

The most damaging insect in the area has been the mountain pine beetle *(Dendroctonus ponderosae),* which attacks lodgepole pine, western white pine, and young stands of ponderosa pine. The Douglas-fir beetle *(Dendroctonus pseudotsugae),* silver fir beetle *(Pseudohylesinus sericeus),* and western pine beetle *(Dendroctonus brevicomis)* have also caused extensive damage. Several other insects are becoming major problems in the area. The western spruce budworm *(Choristoneura occidentalis) is* highly destructive to Douglas-fir, western larch, grand fir, subalpine fir, and Englemann spruce. The Douglas-fir tussock moth *(Orgyia pseudotsugata)* can cause widespread defoliation. Outbreaks of the moth develop explosively and after about 3 years subside abruptly. The balsam woolly aphid *(Adelges piceae)* has become widely established and is highly destructive to Pacific silver fir, subalpine fir, and grand fir (16).

Dwarf mistletoe *(Arceuthobium)* is widespread in the survey area and is a major factor in tree mortality and volume loss. This parasite attacks pines, Douglas-fir, and western larch of all ages. Control of dwarf mistletoe is difficult and costly, but removal of infected trees during harvesting can reduce spread of the disease. Many other diseases such as root rot, heart rot, needle scale, and rust are present and may be serious in a given locality.

Douglas-fir and ponderosa pine provide about 55 percent of the available sawtimber in the area, true firs about 25 percent, western larch and hemlock each about 7 percent, and lodgepole pine about 4 percent. Normal mortality is a continuous problem, and it results in a considerable volume of salvable deadwood. The lack of concentrated volumes, however, often makes harvesting economically unfeasible. Historically, the forest industry in the survey area has been oriented primarily to sawn products. Product diversification and changing economics are now providing markets for smaller logs and minor species.

Soils vary in their ability to produce trees and in the limitations and hazards associated with harvesting them. Depth, fertility, texture, and the available water capacity of soils are among the factors that influence tree growth. Elevation, aspect, and climate determine the kinds of trees that can be expected to grow on any site, especially in mountainous areas. Each map unit in the section "Detailed soil map units" suitable for producing wood crops gives information concerning woodland productivity, limitations for harvesting timber, concerns for producing timber, and common forest understory plants.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol,* a number, indicates the potential annual production of wood fiber. It is expressed in terms of cubic meters per hectare per year for an indicator tree species. The number 1 indicates a potential production of 1 cubic meter per hectare per year, number 2 indicates a potential production of 2 cubic meters per hectare per year, and so on. A mean annual increment of 1 cubic meter per hectare equals about 14.3 cubic feet per acre. Yields in cubic meters are computed at the culmination of the mean annual increment for the first species listed under common trees. These yields are reduced as appropriate when the stocking of the basal area is consistently below normal *(13,14).*

The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *a* indicates that limitations or restrictions are insignificant. The letter c indicates that clay is in the upper part of the soil; d, restricted rooting depth; f, high content of coarse fragments in the soil profile; r, steep slopes; s, sandy texture; t, toxic substances in the soil; w, excessive water in or on the soil; and x, a large amount of stones on the surface or rock outcroppings. If a soil has more than one limitation, priority in placing the soil into a limitation class is as follows: x, w, t, d, c, s, f, and r.

In table 7 the soils are also rated for a number of factors to be considered in woodland management. *slight, moderate,* and *severe* are used to indicate the degree of the major soil limitations.

Equipment limitation ratings refer to the limits placed on the year-round or seasonal use of equipment. A rating of *slight* indicates that equipment use normally is not restricted to a particular kind of equipment or time of year because of soil or climatic factors. *Moderate* indicates a short seasonal limitation because of soil wetness, a fluctuating water table, or some other factor. *Severe* indicates a seasonal limitation, a need for special equipment such as a cable-yarding logging system, or a limitation in the use of equipment.

Steepness of slope and soil wetness are the main factors that cause equipment limitations. As slope gradient and length increase, use of wheeled equipment becomes more difficult. On steeper slopes tracked equipment must be used. On the steepest slopes, even tracked equipment cannot be operated safely and more sophisticated systems must be used. Soil wetness, especially where the soil material is fine textured, can severely limit the use of equipment and make harvesting practical only during the dry period in summer.

Seedling mortality ratings refer to the probability of death of naturally occurring or planted tree seedlings of the principal species on the soils. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that is properly planted or germinates naturally during a period of sufficient soil moisture. *Slight* indicates no problem is expected under normal conditions. *Moderate* indicates some problems of mortality can be expected and extra precautions are advisable. *Severe* indicates that mortality will be high, replanting may be necessary, and extra precautions are essential for successful reforestation. Soil wetness; droughtiness of the surface layer, especially on south- or southwest-facing slopes; limited rooting depth; the kind of soil texture; and the conditions on ridgetops account for most seedling mortality problems. To offset these limitations, larger than normal planting stock, special site preparation, surface drainage, or reinforcement planting may be needed.

Windthrow hazard ratings consider the soil characteristics that affect the development of tree roots and the ability of the soil to hold tree roots firmly. A rating of *slight* indicates that trees normally are not blown down by wind; strong winds may break trees but not uproot them. *Moderate* indicates that few trees may be blown down during periods of excessive soil wetness and strong winds. *Severe* indicates that many trees may be blown down during periods of excessive soil wetness and moderate or strong winds. Restricted rooting depth because of a high water table, underlying bedrock, or an impervious layer and poor anchoring of roots because of the sandy texture of the surface layer and subsoil are responsible for most windthrow problems. *Moderate* and *severe* ratings indicate the need for more care in thinning the edges of woodland stands, periodic salvage of windthrown trees, and an adequate road and trail system to allow for salvage operations.

Plant competition ratings refer to the likelihood of the invasion or growth of undesirable species when openings are made in the tree canopy. The invading plants compete with naturally established or planted seedlings for available growing space and hinder the development of a fully stocked stand of desirable trees. In areas that have low annual precipitation or limited rainfall during the growing season, generally on the eastern fringe of the forested zones, plants compete for the limited amount of available soil moisture. *A slight* rating indicates that desirable plants are not likely to delay the development of natural reforestation and that planted tree seedlings have good potential for development without excessive competition. *Moderate* indicates that competition will delay natural or planted reforestation. *Severe* indicates that competition will prevent natural or planted reforestation. In many cases, the key to predicting plant competition problems is the quantity and proximity of seed sources of undesirable plants. *Moderate* and *severe* ratings indicate the need for careful and thorough clean-up after harvesting in preparation for reforestation and for use of mechanical or chemical treatment to retard growth of competing plants and allow tree seedlings to develop.

The *potential productivity* of *common trees* on a soil is expressed as *a site index.* This index is determined by taking height and age measurements on selected trees within stands of a given species. The procedure for doing this is given in the appropriate site index tables. The site index applies to fully stocked, even-aged, unmanaged stands growing on a particular soil. The highest timber yields can be expected from soils that have the highest site indexes.

Site index values can be converted into estimated yields of trees at various ages by using the applicable yield tables. In this survey area, USDA Technical Bulletin 630 (15) was used to determine the site index and yield estimates for ponderosa pine and for inland Douglas-fir. For lodgepole pine the site indexes are based on work by Alexander *(3)* and yields on work by Myers (17). Site indexes and yields for western larch are based on work by Schmidt (18). Site indexes for Englemann spruce and subalpine fir are based on tables by Alexander (4), and yield estimates are provided by Edminster (9). Estimates of site indexes for grand fir were based on data from the Washington State Department of Natural Resources (24); estimates of yield were not available. Common trees are listed in the same order as that of their general occurrence observed in the soil map unit.

Trees to plant are those that are used for reforestation or, if suitable conditions exist, are favored for natural regeneration. Species listed are suited to the soils and to commercial wood production. The growth rate and wood

quality of species vary, which influences their economic value and marketability. The desired product, topographic position, seedling availability, and personal preference are factors that can influence the choice of trees to use for reforestation.

woodland understory vegetation

Nearly all of the 138,000 acres of woodland in the survey area is grazable and is extremely important for both wildlife and livestock. Many species of wildlife use the woodland as range in summer and winter, and many livestock operations, both cattle and sheep, depend on it for grazing in summer and early in fall.

The woodland understory plant communities are ponderosa pine-shrub-grass at the lower elevations, Douglas-fir-pinegrass at the intermediate elevations, and subalpine fir-huckleberry at the higher elevations.

Management practices applicable to grazable understory are discussed in the section "Rangeland."

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive.

Table 8 shows, for each soil suitable for woodland use, the potential for producing understory vegetation. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants up to a height of 4 1/2 feet. It is expressed in pounds per acre of air-dry vegetation in favorable, normal, and unfavorable years. In a favorable year, soil moisture is above average during the optimum part of the growing season; in a normal year, it is below average.

Table 8 also lists the common names of the characteristic vegetation on each soil and the percentage composition, by air-dry weight, of each kind of plant. The table shows the kind and percentage of understory plants expected under a canopy density that is most nearly typical of woodland in which the production of wood crops is highest.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. For those soils not listed in this table, the low average annual precipitation or soil droughtiness is considered to be too severe for windbreak establishment or survival; however, a few of the soils may be suitable for windbreaks if irrigated. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

By Donna L. Storch, range conservationist, and Ivan L. Lines, Jr., biologist, Soil Conservation Service.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

Many of the soils in this survey area are used as irrigated cropland, nonirrigated cropland, or rangeland, or as all of these. If any areas of a given soil are used as irrigated cropland, the ratings for that soil given in table 11 are those applicable to irrigated cropland. Otherwise, the soil is rated as nonirrigated cropland or as rangeland. Refer to the appropriate map unit in the section "Detailed soil map units" to determine if some areas of a soil are used as irrigated cropland.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, crested wheatgrass, orchardgrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild

herbaceous plants are bluebunch wheatgrass, needlegrass, pigweed, mustard, cheatgrass, filaree, and sedges.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, and available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, and larch.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are Russian-olive, dogwood, bitterbrush, snowberry, and sagebrush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, rushes, sedges, and cattails.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include California quail, pheasant, meadowlark, skunk, cottontail, and raccoon.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, thrushes, woodpeckers, songbirds, squirrels, raccoon, deer, and elk.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, redwing blackbird, kingfisher, muskrat, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include mule deer, sage grouse, meadowlark, coyote, and chukar.

In the following paragraphs use and management of the general soil map units for wildlife habitat are discussed.

T he survey area has a wide variety of soils, landforms, precipitation zones, and vegetation. Elevation ranges from 600 feet to more than 7,000 feet. Precipitation ranges from 6 to 50 inches. The vegetation includes grasses and shrubs in areas of arid land, irrigated and nonirrigated crops, and subalpine forest. Thus, the area provides habitat that supports many kinds of wildlife.

Most of the grass-shrub type of vegetation originally in general soil map units 1 to 5 has been replaced by intensively farmed irrigated crops. These units provide habitat for quail, pheasant, dove, rabbit, and waterfowl as well as for numerous nongame birds and mammals. Map units 1 and 2 include numerous wetlands that provide valuable habitat for waterfowl, wading birds, and other wetland wildlife. The large trees in the vicinity of wetlands and streams provide valuable perches and nesting sites for hawks and owls and for cavity nesting birds such as woodpeckers and bluebirds. Areas of farmland that are interspersed with wooded streambanks, wetlands, vegetated irrigation ditches, and patches of noncultivated land still support good populations of wildlife. Habitat can be maintained or improved in most areas by leaving the cover undisturbed along fence rows, in ditches, and in areas of wetland and by planting hedgerows, windbreaks, and herbaceous cover on noncultivated or eroding land.

The upland soils in general soil map units 6 to 11 are used as rangeland, for orchards, and as cropland. These units provide habitat for the kinds of wildlife normally present on cropland as well as for rangeland wildlife such as chukar, mule deer, coyote, bighorn sheep, and wintering elk. Bighorn sheep and wintering elk are mainly on map units 9, 10, and 11. The orchards and cropland support more wildlife if the noncultivated areas are maintained in woody or herbaceous cover. Properly grazed pastures also provide food and cover. Pesticides should be used sparingly in these areas.

The carrying capacity for rangeland wildlife is greatest in those areas that have not been overgrazed. At some stage of their life cycle, most species of rangeland wildlife are dependent on the presence of woody and herbaceous vegetation that is adjacent to streams or other wet areas. The key to maintaining an abundance of rangeland wildlife is to protect the native vegetation from overgrazing, burning, spraying, or other disturbance particularly in riparian zones. Species such as quail and

chukar will benefit from the development of wildlife watering facilities.

The timbered soils at the higher elevations in general soil map units 12 and 13 provide habitat for elk, deer, bear, forest grouse, and numerous nongame birds and mammals. These areas are the summer range as well as the calving and fawning areas for elk and deer. Cliffs and rocky ledges are preferred nesting sites for eagles, falcons, and other birds of prey. Snags provide nesting and perching sites for birds of prey and for cavity nesting birds such as bluebirds and woodpeckers. As in other areas, undisturbed vegetation along streams provides important habitat necessary for the well-being of many species.

Grazing in wooded areas should be managed to accommodate the forage needs of wildlife and to protect riparian zones. Logging should be done in small, irregularly shaped patches. Snags and riparian zones should be protected from logging activities. To reduce soil erosion and provide food and cover for wildlife, areas that are logged or burned should be seeded to grasses and legumes. After logging has been completed, unneeded roads should be closed and reseeded to prevent undue disturbance to wildlife, particularly big game animals.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, and natural soil structure aggregation. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to

bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and suffidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary facilities

Table 13 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function

unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain

sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected

by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SF, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Rock fragments in the soil reduce the K value; therefore, the K values expresed in table 17 reflect the amount of rock fragments in the soil. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Depending on the total content of rock fragments in the surface layer, soils containing rock fragments can be assigned to any of the wind erodibility groups. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 17, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Tables 18 and 19 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly *wet.* These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table-that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given in table 19 if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (23). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 20, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Five soil orders are recognized in this survey area. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll *(Aqu,* meaning water, plus *oll,* from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls *(Hapl,* meaning minimal horizonation, *plus aquoll,* the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Cumulic* identifies the subgroup that has a mollic epipedon that is thicker than that of the Typic great group. An example is Cumulic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Cumulic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (21). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (23). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Ashue series

The Ashue series consists of very deep, well drained soils on low terraces in stream valleys. These soils formed in alluvium. Slopes range from 0 to 2 percent. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Ashue loam, about 3 miles southeast of Naches, about 450 feet east and 420 feet south of the northwest corner of sec. 23, T. 14 N., R. 17 E.

Ap-0 to 10 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; 5 percent pebbles; mildly alkaline; gradual wavy boundary.

B21t-10 to 15 inches; yellowish brown (10YR 5/4) very gravelly heavy loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many fine roots; common fine tubular pores; common thin clay films on faces of peds; 45 percent pebbles; mildly alkaline; clear wavy boundary.

B22t-15 to 29 inches; yellowish brown (10YR 5/4) very gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, very friable, sticky and plastic; common fine roots; common fine pores; common thin clay films on faces of peds; 40 percent pebbles and 10 percent cobbles; mildly alkaline; abrupt wavy boundary.

C1-29 to 34 inches; dark yellowish brown (10YR 4/4) very gravelly sandy loam, dark brown (10YR 3/3) moist; massive; soft, friable, nonsticky and nonplastic; few fine roots; 45 percent pebbles and 15 percent cobbles; mildly alkaline; abrupt wavy boundary.

IIC2-34 to 60 inches; dark grayish brown (10YR 4/2) extremely gravelly sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; few fine roots; 60 percent pebbles and 15 percent cobbles; mildly alkaline.

The mollic epipedon is 7 to 12 inches thick. The profile is neutral or mildly alkaline.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist.

The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 or 4 when dry or moist. It is very gravelly loam or very gravelly sandy clay loam.

The C and IIC horizons have hue of 10YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4 when dry or moist. The C horizon is very gravelly sandy loam or very gravelly loam. The IIC horizon is extremely gravelly sand or extremely cobbly sand.

Bakeoven series

The Bakeoven series consists of very shallow, well drained soils on uplands. These soils formed in loess and in residuum derived from basalt. Slopes range from 0 to 45 percent. Elevation is 1,500 to 3,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typical pedon of Bakeoven very cobbly silt loam, 0 to 30 percent slopes, about 10 miles north of Sunnyside, about 1,600 feet north and 300 feet east of the southwest corner of sec. 6, T. 11 N., R. 23 E.

A1-0 to 4 inches; brown (10YR 5/3) very cobbly silt loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few fine tubular pores; 15 percent pebbles and 35 percent cobbles; neutral; abrupt wavy boundary.

B21-4 to 7 inches; dark yellowish brown (10YR 4/4) gravelly clay loam, dark brown (10YR 31/3) moist; moderate medium angular blocky structure; hard, firm, sticky and plastic; common very fine roots; few fine tubular pores; 20 percent pebbles and 5 percent cobbles; neutral; abrupt wavy boundary.

B22-7 to 10 inches; dark yellowish brown (10YR 4/4) very gravelly clay loam, dark brown (10YR 3/3) moist; moderate fine angular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine tubular pores; 40 percent pebbles and 15 percent cobbles; neutral; abrupt wavy boundary.

IIR-10 inches; basalt.

Depth to basalt ranges from 4 to 12 inches. The solum has but of 10YR or 7.5YR. The A horizon has chroma of 2 or 3 when dry or moist. The B2 horizon averages more than 35 percent coarse fragments. It is gravelly clay loam, very gravelly clay loam, very gravelly loam, or very cobbly loam.

Bickleton series

The Bickleton series consists of deep, well drained soils on uplands. These soils formed in loess and in residuum derived from basalt. Slopes range from 0 to 30 percent. Elevation is 2,600 to 3,200 feet. The average annual precipitation is 11 to 14 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 120 to 160 days.

Typical pedon of Bickleton silt loam, 0 to 5 percent slopes, about 17 miles southwest of Mabton, about 2,300 feet west and 1,100 feet north of the southeast corner of sec. 35, T. 7 N., R. 20 E.

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

A12-5 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; abrupt smooth boundary.

B21-10 to 19 inches; brown (10YR 4/3) heavy silt loam, dark brown (10YR 3/3) moist; moderate coarse prismatic structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; common very fine pores; mildly alkaline; abrupt smooth boundary.

B22-19 to 26 inches; brown (10YR 5/3) heavy silt loam, dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate medium prismatic; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; common very fine pores; mildly alkaline; abrupt smooth boundary.

C1-26 to 35 inches; pale brown (10YR 6/3) heavy silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; 10 percent gravel; slightly effervescent; mildly alkaline; abrupt smooth boundary.

IIC2ca-35 to 42 inches; brown (10YR 5/3) extremely gravelly silty clay loam, dark brown (10YR 4/3) moist; massive; hard, friable, sticky and plastic; few very fine roots; few very fine pores; 60 percent pebbles and 10 percent cobbles; violently effervescent; moderately alkaline; abrupt smooth boundary.

IIR-42 inches; basalt.

Depth to basalt ranges from 40 to 60 inches. The 10- to 40-inch control section is 18 to 25 percent clay. The mollic epipedon is 10 to 16 inches thick.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is neutral or mildly alkaline.

The B2 horizon has value of 4 to 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is neutral or mildly alkaline.

The C horizon is heavy silt loam or silty clay loam.

The IIC horizon is very gravelly silt loam or extremely gravelly silty clay loam. It is mildly alkaline or moderately alkaline.

Bocker series

The Bocker series consists of very shallow, well drained soils on mountaintops and broad ridgetops. These soils formed in residuum derived from basalt and containing minor amounts of loess. Slopes range from 0 to 25 percent. Elevation is 2,800 to 5,500 feet. The average annual precipitation is 18 to 40 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 85 to 130 days.

Typical pedon of Bocker very cobbly loam, 0 to 25 percent slopes, about 12 miles west of Cowiche, about 600 feet south and 400 feet east of the northwest corner of sec. 4, T. 13 N., R. 15 E.

A1-0 to 3 inches; dark grayish brown (10YR 4/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; 30 percent pebbles and 20 percent cobbles; slightly acid; abrupt smooth boundary.

B2-3 to 7 inches; dark brown (10YR 4/3) very cobbly loam, very dark grayish brown (10YR 3/2) moist; weak very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; 15 percent pebbles and 25 percent cobbles; slightly acid; abrupt wavy boundary.

R-7 inches; fractured basalt.

From 10 to 20 percent of the surface is covered with cobbles. The mollic epipedon is 5 to 10 inches thick. Depth to fractured basalt ranges from 5 to 10 inches.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 3 or 4 when dry.

The B horizon has value of 4 or 5 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when dry and 2 or 3 when moist. It is very cobbly loam or very cobbly silt loam.

Burke series

The Burke series consists of moderately deep, well drained soils on uplands. These soils formed in loess overlying a lime- and silica- cemented duripan. Slopes range from 2 to 40 percent. Elevation is 1,000 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typical pedon of Burke silt loam, 2 to 5 percent slopes, about 5 miles north of Outlook, about 700 feet north and 50 feet east of the southwest corner of sec. 30, T. 11 N., R. 22 E.

Ap-0 to 7 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; mildly alkaline; abrupt smooth boundary.

AC-7 to 16 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine pores; mildly alkaline; abrupt wavy boundary.

C1-16 to 24 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine pores; moderately alkaline; abrupt smooth boundary.
C2ca-24 to 25 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine pores; secondary lime in root channels; strongly effervescent; moderately alkaline; abrupt smooth boundary.
C3casim-25 inches; indurated lime- and silica-cemented duripan.

Depth to the duripan ranges from 20 to 40 inches. The duripan is underlain by basalt at a depth of 30 inches or more. The profile has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 2 or 3 when dry or moist. The A horizon is silt loam or very stony silt loam. The AC and C horizons are silt loam or very fine sandy loam. They are mildly alkaline to strongly alkaline.

Carmack series

The Carmack series consists of very deep, well drained soils on uplands and north-facing mountainsides. These soils formed in residuum derived dominantly from conglomerate and tuffaceous sandstone. Slopes range from 0 to 75 percent. Elevation is 2,200 to 3,500 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typical pedon of Carmack loam, 0 to 25 percent slopes, about 3 miles southwest of Nile, about 1,000 feet north and 400 feet west of the southeast corner of sec. 16, T. 15 N., R. 15 E.

O1-2 inches to 0; decomposing forest litter.
A11-0 to 1 inch; grayish brown (10YR 5/2) and light gray (10YR 7/2) loamy sand, very dark grayish brown (10YR 3/2) and light brownish gray (10YR 6/2) moist; single grain; loose; few very fine and fine roots; medium acid; abrupt smooth boundary.
A12-1 inch to 15 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine irregular pores; 5 percent pebbles; slightly acid; abrupt smooth boundary.
B1-15 to 21 inches; brown (10YR 5/3) loam, dark yellowish brown (10YR 3/4) moist; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine irregular pores; medium acid; clear wavy boundary.
B2t-21 to 43 inches; pale brown (10YR 6/3) silty clay loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine and fine roots and common medium roots; common very fine irregular pores; common thin clay films on faces of peds; medium acid; clear wavy boundary.
B3-43 to 60 inches; pale brown (10YR 6/3) loam, dark yellowish brown (10YR 3/4) moist; moderate very fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few fine and common medium roots; few very fine irregular pores; medium acid.

Thickness of the mollic epipedon is 10 to 15 inches. The control section is 0 to 10 percent pebbles and cobbles. Base saturation ranges from 55 to 65 percent.

The A11 horizon is discontinuous in some pedons. The A12 horizon has hue of 7.5YR or 10YR, and it has chroma of 2 or 3 when dry or moist. It is loam or cobbly loam.

The B1 horizon has hue of 7.5YR or 10YR, value of 5 to 7 when dry and 3 to 5 when moist, and chroma of 2 or 3 when dry and 2 to 4 when moist. It is loam, silt loam, or gravelly loam. The B2t horizon has value of 6 or 7 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry and 2 to 4 when moist. It is silty clay loam, clay loam, or loam. The B3 horizon is loam or silt loam.

Cleman series

The Cleman series consists of very deep, well drained soils on flood plains and alluvial fans. These soils formed in alluvium. Slopes range from 0 to 15 percent. Elevation is 700 to 1,600 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typical pedon of Cleman very fine sandy loam, 0 to 2 percent slopes, about 6 miles southeast of Moxee City, about 680 feet west and 100 feet north of the southeast corner of sec. 13, T. 12 N., R. 20 E.

Ap-0 to 10 inches; brown (10YR 5/3) very fine sandy loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common fine pores; mildly alkaline; clear wavy boundary.
C1-10 to 25 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; few medium roots; mildly alkaline; abrupt wavy boundary.
C2-25 to 28 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; mildly alkaline; abrupt wavy boundary.

C3-28 to 40 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.
C4-40 to 45 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.
C5-45 to 55 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 3/4) moist; single grain; loose; mildly alkaline; abrupt wavy boundary.
C6-55 to 60 inches; yellowish brown (1OYR 5/4) very fine sandy loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, slightly sticky and nonplastic; mildly alkaline.

Thickness of the mollic epipedon is 7 to 20 inches. The profile is neutral or mildly alkaline. The control section is 0 to 5 percent coarse fragments.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 to 4 when moist or dry. It is stratified silt loam to sandy loam above a depth of 40 inches. Below a depth of 40 inches the horizon is stratified silt loam to loamy fine sand and is 0 to 15 percent rock fragments.

Clint series

The Clint series consists of moderately deep, well drained soils on uplands. These soils formed in loess and in residuum derived from basalt. Slopes range from 8 to 75 percent. Elevation is 2,300 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 120 to 135 days.

Typical pedon of Clint very stony loam, 15 to 45 percent slopes, about 7 miles west of Cowiche, about 1,000 feet east and 1,200 feet south of the northwest corner of sec. 29, T. 14 N., R. 16 E.

A11-0 to 6 inches; reddish brown (5YR 5/3) very stony loam, dark reddish brown (5YR 3/3) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; 10 percent pebbles, 5 percent cobbles, and 10 percent stones; neutral; clear wavy boundary.
A12-6 to 10 inches; reddish brown (5YR 5/3) gravelly loam, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few fine tubular pores; 15 percent pebbles and 5 percent cobbles; neutral; abrupt wavy boundary.
B2-10 to 19 inches; reddish brown (5YR 5/3) very gravelly loam, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few fine tubular pores; 40 percent pebbles and 10 percent cobbles; neutral; abrupt irregular boundary.
C1-19 to 28 inches; dark brown (7.5YR 4/2) extremely gravelly loam, dark brown (7.5YR 3/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots matted between rock fragments; 60 percent pebbles and 15 percent cobbles; neutral; abrupt wavy boundary.
R-28 inches; fractured basalt.

Thickness of the solum is 13 to 20 inches. Depth to basalt is 20 to 40 inches. Thickness of the mollic epipedon is 10 to 15 inches. The control section is 18 to 25 percent clay and 40 to 70 percent coarse fragments. Base saturation is more than 75 percent.

The A horizon has hue of 5YR or 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 5YR or 7.5YR, and it has value of 4 or 5 when dry and 2 or 3 when moist. It is very gravelly loam or very gravelly silt loam.

The C horizon has hue of 5YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 or 3 when moist or dry. It is extremely gravelly loam, extremely gravelly silt loam, or extremely gravelly sandy clay loam.

Cowiche series

The Cowiche series consists of very deep, well drained soils on uplands. These soils formed in residuum derived from sandstone and have a mantle of loess. Slopes range from 2 to 30 percent. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 135 to 160 days.

Typical pedon of Cowiche loam, 8 to 15 percent slopes, about 6 miles northeast of Naches, about 2,000 feet east and 1,280 feet south of the northwest corner of sec. 27, T. 15 N., R. 18 E.

Ap-0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate very thin platy structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary.
A12-3 to 10 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; few fine tubular pores; neutral; clear wavy boundary.

B1-10 to 20 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium prismatic structure; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; neutral; clear wavy boundary.

B2t-20 to 29 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; few thin and very thin clay films in pores and on faces of peds; neutral; clear wavy boundary.

B3-29 to 35 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; mildly alkaline; abrupt wavy boundary.

C1-35 to 45 inches; pale brown (10YR 6/3) very fine sandy loam. brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; mildly alkaline; clear wavy boundary.

IIC2ca-45 to 60 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 3/3) moist; massive; hard, firm, nonsticky and nonplastic; few fine roots; segregated lime on upper boundary of horizon and in root channels; violently effervescent; moderately alkaline.

Thickness of the mollic epipedon is 10 to 20 inches. The argillic horizon is 0 to 5 percent coarse fragments and 18 to 30 percent clay.

The A1 horizon has value of 4 or 5 when dry, and it has chroma of 2 or 3 when dry or moist. It is neutral or mildly alkaline.

The B2 horizon has value of 5 to 7 when dry, and it has chroma of 3 or 4 when dry or moist. It is heavy silt loam, heavy loam, clay loam, or sandy clay loam. It is neutral or mildly alkaline.

The C horizon has chroma of 2 or 3 when moist or dry. It is loamy fine sand, very fine sandy loam, sandy loam, or loamy sand. It is 0 to 15 percent coarse fragments.

Darland series

The Darland series consists of very deep, well drained soils on mountainsides. These soils formed in colluvium derived from basalt. Slopes range from 45 to 75 percent. Elevation is 5,000 to 6,900 feet. The average annual precipitation is 25 to 45 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 100 to 120 days.

Typical pedon of Darland stony loam, 45 to 75 percent slopes, about 14 miles west of Tampico, about 2,900 feet west and 2,550 feet north of the southeast corner of sec. 23, T. 12 N., R. 13 E.

A11-0 to 8 inches; dark yellowish brown (10YR 4/4) stony loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; few fine pores; stones on 5 percent of surface; neutral; abrupt smooth boundary.

A12-8 to 14 inches; dark brown (10YR 4/3) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; soft, friable, slightly sticky and slightly plastic; common fine and medium roots; few fine pores; 35 percent pebbles and 5 percent cobbles; neutral; clear wavy boundary.

A13-14 to 31 inches; dark brown (10YR 4/3) very cobbly loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; 35 percent pebbles and 25 percent cobbles; slightly acid; clear wavy boundary.

B2-31 to 43 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; 15 percent pebbles and 65 percent cobbles; slightly acid; gradual wavy boundary.

C-43 to 60 inches; dark yellowish brown (10YR 4/4) extremely cobbly sandy loam, dark brown (10YR 3/3) moist; single grain; loose; few fine and medium roots; 10 percent pebbles, 70 percent cobbles, and 10 percent stones; slightly acid.

Thickness of the mollic epipedon is 20 to 33 inches. The control section is 40 to 80 percent rock fragments.

The A horizon has value of 4 or 5 when dry, and it has chroma of 2 or 3 when moist.

The B horizon has value of 4 or 5 when dry. It is very gravelly loam, very cobbly loam, or extremely cobbly loam.

The C horizon has value of 4 or 5 when dry. It is very cobbly or extremely cobbly sandy loam.

Esquatzel series

The Esquatzel series consists of very deep, well drained soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 5 percent. Elevation is 650 to 1,500 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 160 days.

Typical pedon of Esquatzel silt loam, 0 to 2 percent slopes, about 4 miles northwest of Buena, about 1,340 feet south and 400 feet east of the northwest corner of sec. 6, T. 11 N., R. 20 E.

Ap1-0 to 4 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium granular structure; soft, friable, nonsticky and slightly plastic; many very fine roots; common fine tubular pores; neutral; abrupt smooth boundary.
Ap2-4 to 8 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine roots; common fine tubular pores; neutral; abrupt smooth boundary.
A13-8 to 17 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; common fine tubular pores; neutral; gradual wavy boundary.
C1-17 to 22 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; common fine tubular pores; mildly alkaline; abrupt wavy boundary.
C2-22 to 46 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; common fine tubular pores; mildly alkaline; abrupt wavy boundary.
C3-46 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots; common fine tubular pores; mildly alkaline.

Thickness of the mollic epipedon ranges from 15 to 20 inches. Depth to carbonates is 40 to 60 inches.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is neutral or mildly alkaline.

The C horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is silt loam but may be stratified with fine sandy loam below a depth of 40 inches. Reaction is mildly alkaline or moderately alkaline.

The Esquatzel soils in this survey area are a taxadjunct to the Esquatzel series because they do not have free carbonates above a depth of 40 inches. This difference, however, does not affect the use and management of the soils.

Fiander series

The Fiander series consists of very deep, somewhat poorly drained, salt- and alkali-affected soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 3 percent. Elevation is 700 to 900 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Fiander silt loam, about 2 miles north of Mabton, about 50 feet east and 1,400 feet south of the northwest corner of sec. 30, T. 9 N., R. 23 E.

A1-0 to 2 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; strong very thin platy structure; slightly hard, friable, slightly sticky and plastic; many fine roots; many fine pores; moderately alkaline; abrupt smooth boundary.
B21t-2 to 9 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; strong coarse prismatic structure; hard, firm, sticky and plastic; many fine roots; few fine pores; thin continuous clay films on faces of peds; slightly effervescent; strongly alkaline; gradual wavy boundary.
B22t-9 to 13 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; faces of peds are very dark brown (10YR 2/2) moist; strong coarse prismatic structure; hard, firm, sticky and plastic; many very fine roots; few fine pores; thin continuous clay films on faces of peds; slightly effervescent; very strongly alkaline; gradual wavy boundary.
B23t-13 to 25 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; moderate medium granular structure; hard, firm, sticky and plastic; few very fine roots; few fine pores; thin continuous clay films on faces of peds; violently effervescent; very strongly alkaline; gradual wavy boundary.
C1-25 to 50 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; violently effervescent; strongly alkaline; abrupt smooth boundary.
C2-50 to 60 inches; brown (10YR 5/3) loamy very fine sand, dark brown (10YR 3/3) moist; single grain; loose; mildly alkaline.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 or 2 when dry or moist. It is moderately alkaline to very strongly alkaline.

The B2t horizon has chroma of 2 or 3 when dry or moist. It is heavy silt loam or silty clay loam and is strongly alkaline or very strongly alkaline.

The C horizon has chroma of 2 or 3 when dry or moist. It is silt loam above a depth of 40 inches and is silt loam or loamy very fine sand below a depth of 40 inches. It is mildly alkaline to strongly alkaline.

Finley series

The Finley series consists of very deep, well drained soils on terraces and alluvial fans. These soils formed in old alluvium. Slopes range from 0 to 15 percent. Elevation is 600 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typical pedon of Finley cobbly fine sandy loam, 0 to 5 percent slopes, about 14 miles north of Sunnyside, about 1,600 feet south and 1,300 feet west of the northeast corner of sec. 24, T. 12 N., R. 22 E.

A1-0 to 4 inches; brown (10YR 5/3) cobbly fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; common very fine tubular pores; 5 percent pebbles and 15 percent cobbles; mildly alkaline; abrupt smooth boundary.
A3-4 to 14 inches; brown (10YR 5/3) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; 5 percent pebbles; mildly alkaline; clear wavy boundary.
B2-14 to 30 inches; yellowish brown (10YR 5/4) very gravelly loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; 45 percent pebbles and 10 percent cobbles; mildly alkaline; abrupt wavy boundary.
IIC-30 to 60 inches; yellowish brown (10YR 5/4) extremely gravelly sand, dark yellowish brown (10YR 3/4) moist; single grain; loose; 60 percent pebbles and 15 percent cobbles; mildly alkaline.

Depth to free lime is 14 to 60 inches. The profile is mildly alkaline or moderately alkaline. The control section is 50 to 75 percent coarse fragments.

The A horizon has value of 5 to 7 when dry and 3 or 4 when moist. It is fine sandy loam, cobbly fine sandy loam, or silt loam.

The B horizon has value of 5 to 7 when dry and 3 or 4 when moist, and it has chroma of 2 to 4 when dry or moist. It is very gravelly loam, very gravelly fine sandy loam, or extremely cobbly sandy loam.

The IIC horizon is very gravelly, very cobbly, extremely gravelly, or extremely cobbly sand or loamy sand.

Gorskel series

The Gorskel series consists of very shallow and shallow, well drained soils on uplifted terraces and foot slopes. These soils formed in loess and old alluvium. Slopes range from 0 to 25 percent. Elevation is 1,200 to 3,000 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of Gorskel very stony loam, 0 to 25 percent slopes, about 2 1/2 miles northeast of Naches, about 200 feet east and 2,300 feet north of the southwest corner of sec. 26, T. 15 N., R. 17 E.

A1-0 to 5 inches; brown (10YR 5/3) very stony loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many fine roots; many fine vesicular pores; 5 percent stones, 30 percent cobbles, and 20 percent pebbles; mildly alkaline; abrupt wavy boundary.
B1t-5 to 8 inches; yellowish brown (10YR 5/4) gravelly heavy loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; soft, friable, slightly sticky and plastic; many fine roots; many very fine vesicular pores; 25 percent pebbles; few thin clay films on faces of peds; mildly alkaline; abrupt wavy boundary.
B2t-8 to 13 inches; dark yellowish brown (10YR 4/4) very gravelly clay loam, dark yellowish brown (10YR 3/4) moist; strong medium angular blocky structure; hard, friable, sticky and plastic; many fine roots; common very fine vesicular pores; 40 percent pebbles and 5 percent cobbles; many moderately thick clay films on faces of peds; mildly alkaline; abrupt *wavy* boundary.
IICsim-13 inches; indurated, silica-cemented gravelly duripan.

Depth to the duripan is 9 to 15 inches. The mollic epipedon is 7 to 9 inches thick.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist.

The B2t horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 or 4 when dry or moist. It is very gravelly loam, very gravelly silt loam, very gravelly silty clay loam, very gravelly clay loam, or very cobbly clay loam.

Gorst series

The Gorst series consists of shallow, well drained soils on dissected terraces. These soils formed in loess and old alluvium. Slopes range from 0 to 30 percent. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typical pedon of Gorst loam, 2 to 15 percent slopes, about 2 miles southwest of Harwood, about 1,140 feet west and 400 feet south of the northeast corner of sec. 33, T. 13 N., R. 17 E.

Ap-0 to 7 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; few fine tubular pores; mildly alkaline; abrupt wavy boundary.

B21-7 to 10 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; moderate medium prismatic structure; hard, firm, slightly sticky and plastic; few very fine roots; common fine tubular pores; 5 percent pebbles and 5 percent cobbles; mildly alkaline; clear wavy boundary.
B22-10 to 15 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; moderate medium angular blocky structure parting to moderate fine blocky; hard, firm, slightly sticky and plastic; few very fine roots; many very fine tubular pores; 5 percent pebbles and 5 percent cobbles; mildly alkaline; abrupt smooth boundary.
IICsim-15 inches; indurated, silica-cemented gravelly duripan.

Depth to the duripan is 12 to 20 inches. Thickness of the mollic epipedon is 7 to 9 inches. The control section is 18 to 25 percent clay.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist. It is loam or cobbly loam.

The B horizon is silt loam or loam and is 0 to 15 percent rock fragments.

Harwood series

The Harwood series consists of moderately deep, well drained soils on highly dissected terraces and uplands. These soils formed in loess and old alluvium. Slopes range from 0 to 60 percent. Elevation is 1,200 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the frost-free season is 135 to 150 days.

Typical pedon of Harwood loam, 2 to 5 percent slopes, about 5 miles southwest of Harwood, about 150 feet south and 1,840 feet east of the northwest corner of sec. 31, T. 13 N., R. 17 E.

A11-0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; neutral; abrupt wavy boundary.
A12-4 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium platy structure parting to moderate thin platy; hard, friable, slightly sticky and slightly plastic; common fine roots; few fine tubular pores; mildly alkaline; clear wavy boundary.
B21-8 to 18 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; 5 percent pebbles; mildly alkaline; clear wavy boundary.
B22-18 to 24 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; moderate medium prismatic structure; hard, firm, slightly sticky and plastic; common fine roots; common fine tubular pores; 5 percent pebbles; mildly alkaline; clear wavy boundary.
B23-24 to 26 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; moderate medium angular blocky structure; very hard, very firm, slightly sticky and plastic; common fine roots; many fine tubular pores; 5 percent pebbles; moderately alkaline; abrupt wavy boundary.
IIC1-26 to 30 inches; brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 3/4) moist; massive; very hard, very firm, sticky and plastic; few fine roots; many fine tubular pores; 25 percent pebbles and 5 percent cobbles; silica coatings on pebbles; moderately alkaline; abrupt smooth boundary.
IIC2sim-30 inches; indurated, silica-cemented gravelly duripan.

Depth to the duripan is 20 to 40 inches. Thickness of the mollic epipedon is 7 to 15 inches.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is loam, silt loam, or very stony silt loam.

The B horizon has value of 5 or 6 when dry and 3 or 4 when moist. It is loam or silt loam.

The IIC horizon has hue of 10YR or 7.5YR, and it has chroma of 3 or 4 when moist or dry. It is gravelly loam or gravelly silt.

Hezel series

The Hezel series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in lacustrine sediment and have a mantle of eolian sand. Slopes range from 0 to 15 percent. Elevation is 650 to 800 feet. The average annual precipitation is 6 to 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free season is 150 to 180 days.

Typical pedon of Hezel loamy fine sand, 2 to 15 percent slopes, about 5 miles southeast of Sunnyside, about 120 feet south and 600 feet west of the northeast corner of sec. 3, T. 9 N., R. 23 E.

Ap-0 to 6 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; common fine roots; neutral; abrupt smooth boundary.
C1-6 to 16 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; few fine roots; neutral; gradual wavy boundary.

C2-16 to 22 inches; light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; single grain; loose; few fine roots; mildly alkaline; abrupt wavy boundary.
IIC3-22 to 28 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; few fine pores; violently effervescent; moderately alkaline; abrupt wavy boundary.
IIC5ca-28 to 34 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; moderate thin platy structure; hard, firm, slightly sticky and plastic; few fine roots; few fine pores; segregated lime; violently effervescent; moderately alkaline; abrupt wavy boundary.
IIC6ca-34 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky and plastic; few fine roots; few fine pores; segregated lime in root channels; violently effervescent; moderately alkaline.

Depth to secondary lime is 20 to 30 inches. The A and C horizons have chroma of 2 or 3 when dry or moist. The IIC horizon has value of 6 or 7 when dry and 3 or 4 when moist, and it has chroma of 1 to 3 when moist or dry. It is stratified silt loam, very fine sandy loam, and fine sandy loam.

Jumpe series

The Jumpe series consists of very deep, well drained soils on mountainsides and long, broad mountain ridges and in canyons. These soils formed in residuum and colluvium derived from basalt and containing minor amounts of loess and volcanic ash. Slopes range from 5 to 65 percent. Elevation is 2,800 to 5,800 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 135 to 170 days.

Typical pedon of Jumpe stony loam, 25 to 45 percent slopes, about 12 miles west of Tampico, about 250 feet east and 500 feet south of the northwest corner of sec. 23, T. 12 N., R. 13 E.

O1-2 inches to 0; decomposing forest litter, needles, and twigs.
A1-0 to 3 inches; brown (10YR 4/3) stony loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; few very fine and fine roots; 5 percent stones; slightly acid; clear wavy boundary.
B21-3 to 19 inches; brown (7.5YR 4/4) extremely cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate very fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few very fine roots and common fine and medium roots; 15 percent pebbles, 40 percent cobbles, and 10 percent stones; medium acid; clear wavy boundary.
B22-19 to 41 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine and fine roots and common medium roots; 15 percent pebbles, 35 percent cobbles, and 20 percent stones; medium acid; clear wavy boundary.
C-41 to 60 inches; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and common medium roots; 30 percent pebbles, 20 percent cobbles, and 10 percent stones; medium acid.

The surface layer is 2 to 10 percent stones. The control section averages 40 to 70 percent rock fragments.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 2 or 3 when dry or moist.

The B2 horizon has value of 4 to 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when dry or moist. It is very cobbly loam or extremely cobbly loam.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6 when dry, and chroma of 3 or 4 when dry or moist. It is very cobbly loam or extremely cobbly loam.

Kiona series

The Kiona series consists of very deep, well drained soils on uplands. These soils formed in loess and in colluvium derived from basalt. Slopes range from 15 to 45 percent. Elevation is 800 to 2,500 feet. The average annual precipitation is 7 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 200 days.

Typical pedon of Kiona stony silt loam, 15 to 45 percent slopes, about 16 miles northwest of Sunnyside, about 1,000 feet north and 300 feet west of the southeast corner of sec. 12, T. 12 N., R. 23 E.

A1-0 to 5 inches; brown (10YR 5/3) stony silt loam, dark brown (10YR 3/3) moist; moderate thin platy structure; soft, very friable, nonsticky and slightly plastic; common fine and very fine roots; common very fine tubular pores; 5 percent pebbles and 5 percent stones; moderately alkaline; abrupt wavy boundary.

B2-5 to 14 inches; pale brown (10YR 6/3) very cobbly silt loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 10 percent pebbles and 40 percent cobbles; moderately alkaline; abrupt irregular boundary.

C1ca-14 to 60 inches; pale brown (10YR 6/3) very cobbly silt loam, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; 10 percent pebbles and 40 percent cobbles; lime is disseminated and segregated in soft masses; violently effervescent; moderately alkaline.

Depth to lime is 12 to 30 inches. The control section averages 50 to 75 percent coarse fragments and is silt loam, very fine sandy loam, or loam. The profile is mildly alkaline or moderately alkaline.

The A and B horizons have value of 5 to 7 when dry and 3 to 5 when moist, and they have chroma of 2 or 3 when dry or moist. The B horizon is cobbly or very cobbly silt loam or loam.

The C horizon has value of 5 to 7 when dry and 3 to 5 when moist, and it has chroma of 2 or 3 when dry or moist. It is very cobbly or extremely cobbly silt loam, fine sandy loam, or loam.

Kittitas series

The Kittitas series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in mixed alluvium. Slopes range from 0 to 2 percent. Elevation is 700 to 1,100 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Kittitas silt loam, about 2 miles northwest of Mabton, about 2,200 feet east and 1,100 feet south of the northwest corner of sec. 25, T. 9 N., R. 22 E.

A11-0 to 2 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and plastic; many fine roots; slightly effervescent; very strongly alkaline; abrupt smooth boundary.

A12-2 to 19 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and plastic; common fine roots; common fine pores; violently effervescent; very strongly alkaline; abrupt wavy boundary.

C1-19 to 30 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; common medium mottles that are gray (10YR 5/1) when moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; violently effervescent; moderately alkaline; abrupt smooth boundary.

C2-30 to 41 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive: slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; violently effervescent; moderately alkaline; gradual wavy boundary.

C3-41 to 52 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; common fine pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

C4-52 to 60 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common fine pores; slightly effervescent; moderately alkaline.

The A horizon has value of 3 to 5 when dry, and it has chroma of 1 or 2 when moist or dry. It is moderately alkaline to very strongly alkaline.

The C horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is silt loam or silty clay loam above a depth of 40 inches and is fine sandy loam, very fine sandy loam, or silt loam below that depth. It is mildly alkaline or moderately alkaline.

Lickskillet series

The Lickskillet series consists of shallow, well drained soils on uplands. These soils formed in loess and in residuum and colluvium derived from basalt. Slopes range from 5 to 45 percent. Elevation is 1,500 to 3,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of Lickskillet very stony silt loam, 5 to 45 percent slopes, about 10 miles south of Sunnyside, about 2,500 feet west and 300 feet north of the southeast corner of sec. 6, T. 11 N., R. 23 E.

A11-0 to 3 inches; grayish brown (10YR 5/2) very stony silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and medium roots; few fine tubular pores; 5 percent pebbles and 10 percent stones; neutral; abrupt smooth boundary.

B1-3 to 8 inches; brown (10YR 5/3) very gravelly silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many medium and few fine roots; few fine tubular pores; 20 percent pebbles and 10 percent cobbles; mildly alkaline; clear wavy boundary.

B21-8 to 12 inches; yellowish brown (10YR 5/4) very gravelly loam, dark yellowish brown (10YR 3/4) moist; moderate fine prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common medium roots; few fine tubular pores; 25 percent pebbles and 10 percent cobbles; mildly alkaline; abrupt wavy boundary.

B22-12 to 20 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium roots; few fine tubular pores; 30 percent pebbles and 30 percent cobbles; mildly alkaline; abrupt wavy boundary.

IIR-20 inches; fractured basalt.

Depth to basalt is 12 to 20 inches. Thickness of the mollic epipedon is 7 to 12 inches. The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. It is silt loam or very stony silt loam. The B horizon has value of 5 or 6 when dry and 3 or 4 when moist. It is very gravelly loam, very cobbly loam, very gravelly silt loam, or very gravelly silty clay loam.

Logy series

The Logy series consists of very deep, well drained soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 5 percent. Elevation is 700 to 1,200 feet. The average annual precipitation is 7 to 10 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Logy silt loam, 0 to 2 percent slopes, about 4 miles southwest of Wiley City, about 2,550 feet south and 80 feet west of the northeast corner of sec. 18, T. 12 N., R. 17 E.

A11-0 to 5 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 5 percent pebbles; neutral; abrupt wavy boundary.

A12-5 to 12 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 10 percent pebbles; neutral; abrupt wavy boundary.

B2-12 to 33 inches; brown (10YR 4/3) extremely gravelly loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 45 percent pebbles and 20 percent cobbles; mildly alkaline; gradual wavy boundary.

IIC1-33 to 45 inches; brown (10YR 4/3) extremely cobbly coarse sand, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; 40 percent pebbles and 40 percent cobbles; mildly alkaline; gradual wavy boundary.

IIC2-45 to 60 inches; grayish brown (10YR 5/2) extremely gravelly coarse sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; 55 percent pebbles and 20 percent cobbles; neutral.

Thickness of the mollic epipedon is 10 to 20 inches. The profile is neutral or mildly alkaline. The control section averages 50 to 80 percent coarse fragments.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 or 2 when dry or moist. It is silt loam or cobbly silt loam. It is 5 to 25 percent coarse fragments.

The B horizon has value of 4 or 5 when dry and 3 or 4 when moist. It is extremely gravelly loam or very gravelly silt loam.

The IIC horizon has value of 3 or 4 when moist, and it has chroma of 2 to 4 when dry or moist.

Loneridge series

The Loneridge series consists of very deep, well drained soils on mountainsides, ridges, benches, and smooth mountaintops. These soils formed in residuum and colluvium derived from basalt and containing a small amount of loess. Slopes range from 0 to 45 percent. Elevation is 2,400 to 5,400 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is about 42 degrees F, and the average length of the growing season, at 28 degrees F, is 135 to 170 days.

Typical pedon of Loneridge stony loam, 0 to 25 percent slopes, about 7 miles northwest of Tampico,

about 800 feet south and 1,700 feet east of the northwest corner of sec. 30, T. 13 N., R. 15 E.

O1-1 inch to 0; decomposing forest litter, needles, and twigs.
A-0 to 3 inches; dark grayish brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; 10 percent pebbles, 5 percent cobbles, and 5 percent stones; medium acid; abrupt smooth boundary.
B11-3 to 13 inches; pale brown (10YR 6/3) very cobbly loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; 20 percent pebbles and 20 percent cobbles; slightly acid; clear smooth boundary.
B12-13 to 23 inches; pale brown (10YR 6/3) very cobbly loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; 35 percent pebbles and 20 percent cobbles; slightly acid; clear wavy boundary.
B21t-23 to 35 inches; dark yellowish brown (10YR 4/4) very cobbly clay, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots and few coarse roots; many thick clay films on faces of peds and on rock fragments; 30 percent pebbles and 20 percent cobbles; slightly acid; gradual wavy boundary.
B22t-35 to 60 inches; yellowish brown (10YR 5/4) very cobbly clay, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, very firm, sticky and very plastic; few very fine roots; many thick clay films on faces of peds and on rock fragments; 25 percent pebbles and 30 percent cobbles; slightly acid.

The control section is 40 to 70 percent rock fragments. The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist, and chroma of 2 or 3 when dry or moist. The B1 horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 or 3 when dry or moist. It is very cobbly loam or very gravelly loam. The B2t horizon has value of 4 to 6 when dry and 3 or 4 when moist. It is very cobbly clay, very cobbly clay loam, or very gravelly clay.

McDaniel series

The McDaniel series consists of very deep, well drained soils on uplands. These soils formed in loess and in colluvium derived from basalt. Slopes range from 5 to 65 percent. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 49 degrees F, and the frost-free season is 120 to 135 days.

Typical pedon of McDaniel very stony loam, 30 to 65 percent slopes, about 6 miles southwest of Cowiche, about 1,800 feet east and 1,600 feet north of the southwest corner of sec. 33, T. 14 N., R. 16 E.

A11-0 to 8 inches; grayish brown (10YR 5/2) very stony loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure parting to moderate fine granular; soft, very friable, nonsticky and slightly plastic; many fine roots; many fine tubular pores; 20 percent pebbles, 5 percent cobbles, and 5 percent stones; neutral; clear wavy boundary.
B21t-8 to 24 inches; brown (7.5YR 5/2) very gravelly clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine roots; few fine tubular pores; 30 percent pebbles and 10 percent cobbles; few thin clay films on faces of peds; neutral; gradual wavy boundary.
B22t-24 to 35 inches; brown (7.5YR 5/4) very cobbly silty clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; many fine tubular pores; 25 percent pebbles and 35 percent cobbles; few thin clay films on faces of peds; neutral; gradual wavy boundary.
B23t-35 to 60 inches; yellowish brown (10YR 5/4) extremely cobbly silty clay loam, dark yellowish brown (10YR 3/4) moist; moderate fine granular structure; hard, firm, sticky and plastic; few fine roots; 25 percent pebbles and 50 percent cobbles; few thin clay films on faces of peds; neutral.

The mollic epipedon is 21 to 30 inches thick. The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. The upper part of the B horizon is very gravelly clay loam, very gravelly silty clay loam, or very cobbly silty clay loam, and the lower part is extremely cobbly silty clay loam, extremely gravelly clay loam, or extremely gravelly silty clay loam.

Meystre series

The Meystre series consists of very deep, well drained soils on uplands. These soils formed in loess and in material derived from sandstone. Slopes range from 0 to 45 percent. Elevation is 2,200 to 3,300 feet. The average annual precipitation is 15 to 20 inches, the average annual air temperature is about 48 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 175 days.

Typical pedon of Meystre loam, 0 to 15 percent slopes, about 12 miles northwest of Naches, about 2,500

feet east and 1,900 feet south of the northwest corner of sec. 2, T. 16 N., R. 16 E.

O1-1 inch to 0; decaying forest litter.
A11-0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium platy structure; soft, very friable, nonsticky and slightly plastic; common fine roots; slightly acid; abrupt smooth boundary.
A1 2-3 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; slightly acid; clear wavy boundary.
B21t-11 to 18 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine roots; few fine tubular pores; few thin patchy clay films on faces of peds; slightly acid; clear wavy boundary.
B22t-18 to 29 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; few thin patchy clay films on faces of peds; slightly acid; clear wavy boundary.
B3t-29 to 41 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; very hard, friable, nonsticky and nonplastic; very few medium roots; few fine tubular pores; very few thin patchy clay films in root channels; neutral; abrupt smooth boundary.
C-41 to 60 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, friable, nonsticky and nonplastic; very few medium roots; few fine tubular pores; neutral.

The mollic epipedon is 10 to 18 inches thick. The control section is 0 to 5 percent coarse fragments. The A horizon is loam or stony loam. The B2 horizon is clay loam or loam. The C horizon has chroma of 3 or 4 when moist. It is fine sandy loam or sandy loam.

Mikkalo series

The Mikkalo series consists of moderately deep, well drained soils on uplands. These soils formed in loess. Slopes range from 0 to 15 percent. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Mikkalo silt loam, 0 to 5 percent slopes, about 11 miles south of Mabton, about 100 feet west and 200 feet north of the southeast corner of sec. 31, T. 7 N., R. 23 E.

Ap-0 to 5 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, friable, nonsticky and slightly plastic; many fine roots; common fine pores; neutral; abrupt smooth boundary.
B2-5 to 20 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure; soft, friable, nonsticky and slightly plastic; common fine roots; common fine pores; mildly alkaline; abrupt wavy boundary.
C1ca-20 to 26 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 5 percent pebbles; violently effervescent; moderately alkaline; abrupt wavy boundary.
C2ca-26 to 30 inches; pale brown (10YR 6/3) gravelly silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 20 percent pebbles; disseminated and segregated lime in root channels and as soft masses; violently effervescent; strongly alkaline; abrupt wavy boundary.
IIR-30 inches; basalt; lime and silica coatings on fractured basalt fragments.

Depth to basalt is 20 to 40 inches. Depth to secondary lime is 20 to 35 inches. The A horizon has value of 4 or 5 when dry, and it has chroma of 2 or 3 when dry or moist. The B horizon is neutral or mildly alkaline. The C horizon has value of 3 or 4 when moist, and it has chroma of 3 or 4 when dry or moist.

Mippon series

The Mippon series consists of very deep, well drained soils on low terraces and flood plains. These soils formed in recent alluvium. Slopes range from 0 to 5 percent. Elevation is 2,400 to 4,800 feet. The average annual precipitation is 20 to 40 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 145 to 170 days.

Typical pedon of Mippon very cobbly silt loam, about 5 miles northwest of Tampico, about 2,200 feet south and 3,700 feet west of the northeast corner of sec. 14, T. 13 N., R. 15 E.

O1-1/2 inch to 0; decomposed and decomposing forest litter.

A11-0 to 7 inches; very dark grayish brown (10YR 3/2) very cobbly silt loam, black (10YR 2/1) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; very few very fine irregular pores; 25 percent pebbles and 35 percent cobbles; neutral; abrupt wavy boundary.

A12-7 to 14 inches; dark grayish brown (10YR 4/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few medium roots; 35 percent pebbles and 25 percent cobbles; slightly acid; abrupt wavy boundary.

C1-14 to 22 inches; brown (10YR 4/3) extremely gravelly sand, dark brown (10YR 3/3) moist; single grain; loose; common very fine roots; 55 percent pebbles and 25 percent cobbles; slightly acid; gradual wavy boundary.

C2-22 to 60 inches; yellowish brown (10YR 5/4) extremely gravelly sand, dark brown (10YR 3/3) moist; single grain; loose; few coarse roots; 70 percent pebbles and 20 percent cobbles; slightly acid.

The mollic epipedon is 10 to 14 inches thick. The control section averages 50 to 90 percent rock fragments.

The A horizon has value of 3 to 5 when dry, and it has chroma of 1 to 3 when moist or dry. It is 35 to 60 percent rock fragments.

The C horizon has chroma of 3 or 4 when dry and 2 or 3 when moist. It is 60 to 90 percent rock fragments. It is very gravelly sandy loam, very cobbly loam, or very gravelly sand in the upper part and is extremely cobbly loamy sand, extremely gravelly sand, or very cobbly sand in the lower part.

Moxee series

The Moxee series consists of shallow, well drained soils on uplands. These soils formed in loess overlying a lime- and silica-cemented duripan. Slopes range from 0 to 30 percent. Elevation is 1,300 to 2,000 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typical pedon of Moxee silt loam, 2 to 15 percent slopes, about 4 miles northeast of Moxee City, about 100 feet north and 110 feet west of the southeast corner of sec. 34, T. 13 N., R. 20 E.

A11-0 to 3 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium platy structure; soft, very friable, nonsticky and slightly plastic; common fine roots; few fine tubular pores; 5 percent pebbles; neutral; abrupt wavy boundary.

A12-3 to 7 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; common fine roots; few fine tubular pores; 3 percent pebbles; mildly alkaline; abrupt wavy boundary.

B2-7 to 11 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and . slightly plastic; common fine roots; few fine tubular pores; 5 percent pebbles and 5 percent cobbles; moderately alkaline; gradual wavy boundary.

IIC1ca-11 to 18 inches; pale brown (10YR 6/3) gravelly silt loam, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and slightly plastic; few fine roots; 20 percent pebbles and 5 percent cobbles; soft masses of lime; strongly effervescent; moderately alkaline; abrupt wavy boundary.

IIC2casim-18 inches; lime- and silica-cemented duripan.

Depth to the duripan is 10 to 20 inches. The duripan is underlain by basalt at a depth of 20 inches or more. The mollic epipedon is 7 to 10 inches thick. The control section averages 10 to 35 percent coarse fragments and is 5 to 10 percent clay. The coarse fragments are lime- and silica-cemented material and basalt.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. It is silt loam or cobbly silt loam and is 0 to 30 percent coarse fragments.

The B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry.

The Cca horizon has value of 5 to 8 when dry and 3 to 6 when moist, and it has chroma of 1 to 4 when moist or dry. It is silt loam or gravelly silt loam.

Naches series

The Naches series consists of very deep, well drained soils on stream terraces in valleys. These soils formed in old alluvium. Slopes range from 0 to 2 percent. Elevation is 700 to 900 feet. The average annual precipitation is 7 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Naches loam, about 1/2 mile north of Gleed, about 700 feet east and 100 feet south of the northwest corner of sec. 32, T. 13 N., R. 18 E.

Ap-0 to 9 inches; grayish brown (1YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; neutral; clear wavy boundary.

B21t-9 to 16 inches; brown (10YR 5/3) heavy loam, dark brown (10YR 3/3) moist; moderate medium angular blocky structure; hard, firm, sticky and plastic; common fine roots and few medium roots; common fine tubular pores; common thin clay films on faces of peds; mildly alkaline; gradual wavy boundary.

B22t-16 to 21 inches; brown (10YR 5/3) heavy loam, dark brown (10YR 3/3) moist; moderate medium angular blocky structure; hard, friable, sticky and plastic; few medium roots and common fine roots; common fine tubular pores; common thin clay films on faces of peds; mildly alkaline; gradual wavy boundary.

B3-21 to 28 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium roots and common fine roots; few fine tubular pores; mildly alkaline; clear wavy boundary.

C1-28 to 34 inches; yellowish brown (10YR 5/4) gravelly loam, dark yellowish brown (10YR 3/4) moist; massive; soft, friable, slightly sticky and slightly plastic; few medium and fine pores; 30 percent pebbles; mildly alkaline; abrupt wavy boundary.

IIC2-34 to 60 inches; dark grayish brown (10YR 4/2) extremely gravelly sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; few very fine roots; 60 percent pebbles and 15 percent cobbles; mildly alkaline.

Thickness of the mollic epipedon is 7 to 16 inches. Depth to the IIC horizon is 25 to 38 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3 when dry or moist.

The B2t horizon has hue of 10YR or 7.5YR, and it has value of 4 or 5 when dry and 3 or 4 when moist. It is heavy loam, sandy clay loam, or clay loam.

The C horizon has value of 4 to 6 when dry and 3 or 4 when moist, and it has chroma of 2 to 4 when dry or moist. It is fine sandy loam, silt loam, or gravelly loam.

The IIC horizon is extremely gravelly loamy sand or extremely gravelly sand.

Naxing series

The Naxing series consists of very deep, well drained soils on mountains and broad mountain ridges. These soils formed in colluvium derived dominantly from basalt and containing volcanic ash and loess. Slopes range from 5 to 65 percent. Elevation is 5,000 to 7,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, is 80 to 110 days.

Typical pedon of Naxing stony loam, 25 to 45 percent slopes, about 11 miles northwest of Tampico, about 2,300 feet west and 1,100 feet south of the northeast corner of sec. 5, T. 12 N., R. 14 E.

O1-1 inch to 0; decomposing forest litter.

A11-0 to 7 inches; brown (10YR 4/3) stony loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few coarse roots and common very fine, fine, and medium roots; stones on 5 percent of surface; medium acid; abrupt *wavy* boundary.

A12-7 to 14 inches; brown (10YR 4/3) cobbly loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure parting to moderate fine granular; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine roots and common medium and coarse roots; 5 percent pebbles, 20 percent cobbles, and 5 percent stones; medium acid; clear smooth boundary.

B2-14 to 21 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; soft, very friable, nonsticky and nonplastic; weakly smeary; few coarse roots and common fine and medium roots; 5 percent pebbles, 30 percent cobbles, and 15 percent stones; medium acid; clear smooth boundary.

C1-21 to 31 inches; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; soft, very friable, slightly sticky and nonplastic; weakly smeary; few fine and common medium roots; 20 percent pebbles, 40 percent cobbles, and 5 percent stones; medium acid; clear smooth boundary.

C2-31 to 60 inches; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few coarse roots; 20 percent pebbles, 40 percent cobbles, and 5 percent stones; medium acid.

The control section averages 40 to 70 percent rock fragments.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3 when moist or dry. It is loam or stony loam.

The B horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 3 or 4 when moist or dry. It is very cobbly loam or very cobbly sandy loam.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 4

or 5 when dry or moist. It is very cobbly loam, very cobbly sandy loam, or extremely cobbly loam.

Odo series

The Odo series consists of very deep, well drained soils on uplands. These soils formed in residuum and colluvium derived dominantly from basalt and containing some loess and volcanic ash. Slopes range from 5 to 35 percent. Elevation is 2,000 to 3,200 feet. The average annual precipitation is 15 to 19 inches, the average annual air temperature is about 46 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 180 days.

Typical pedon of Odo cobbly silt loam, 5 to 35 percent slopes, about 4 miles southwest of Tampico, about 1,300 feet north and 100 feet east of the southwest corner of sec. 22, T. 12 N., R. 15 E.

O1-3 inches to 0; decomposing forest litter.

A1-0 to 18 inches; brown (10YR 4/3) cobbly silt loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots and common fine roots; many very fine irregular pores; 10 percent pebbles and 10 percent cobbles; slightly acid; clear wavy boundary.

B21-18 to 32 inches; yellowish brown (10YR 5/4) gravelly loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common medium and fine roots; many very fine irregular pores; 30 percent pebbles; slightly acid; clear wavy boundary.

B22-32 to 60 inches; yellowish brown (10YR 5/4) gravelly loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; many very fine irregular pores; 20 percent pebbles; slightly acid.

The mollic epipedon is 12 to 18 inches thick. The control section averages 15 to 30 percent coarse fragments. The A horizon has hue of 7.5YR or 10YR, and it has value of 3 or 4 when dry. The B horizon has hue of 5YR, 7.5YR, or 10YR, and it has value of 4 or 5 when dry.

Outlook series

The Outlook series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 3 percent. Elevation is 650 to 2,000 feet. The average annual precipitation is 6 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 160 days.

Typical pedon of Outlook silt loam, about 2 miles northeast of Outlook, about 1,900 feet west and 2,600 feet south of the northeast corner of sec. 24, T. 10 N., R. 21 E.

Ap1-0 to 2 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots; violently effervescent; strongly alkaline; abrupt wavy boundary.

Ap2g-2 to 4 inches; very dark grayish brown (2.5Y 3/2) silt loam, grayish brown (2.5Y 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots; violently effervescent; strongly alkaline; clear wavy boundary.

A3g-4 to 8 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots; violently effervescent; strongly alkaline; clear wavy boundary.

B2g-8 to 18 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common medium distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; few fine tubular pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

Cg-18 to 60 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few tubular pores; moderately alkaline.

The profile is moderately alkaline or strongly alkaline. The 10- to 40-inch control section is very fine sandy loam or silt loam.

The Ap1 horizon has value of 2 or 3 when moist and 4 or 5 when dry. It is silt loam or fine sandy loam. The Ag horizons have mottles that have value of 4 or 5.

The Bg horizon has value of 3 to 5 when moist and 5 to 7 when dry. It has mottles that have value of 4 or 5.

The Cg horizon has value of 3 to 5 when moist and 5 to 7 when dry. It has mottles that have value of 4 or 5. The horizon is silt loam or very fine sandy loam.

Prosser series

The Prosser series consists of moderately deep, well drained soils on uplands. These soils formed in loess and alluvium. Slopes range from 0 to 15 percent. Elevation is 300 to 1,150 feet. The average annual precipitation is 6 to 9 inches, the average annual air

temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typical pedon of Prosser silt loam, 0 to 15 percent slopes, about 11 miles southeast of Mabton, about 2,520 feet east and 700 feet north of the southwest corner of sec. 26, T. 7 N., R. 23 E.

Ap-0 to 4 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; mildly alkaline; abrupt smooth boundary.

B2-4 to 14 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; many very fine tubular pores; mildly alkaline; clear smooth boundary.

C1-14 to 19 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; moderately alkaline; abrupt wavy boundary.

C2ca-19 to 24 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine tubular pores; mycelial lime; violently effervescent; moderately alkaline; abrupt wavy boundary.

C3ca-24 to 33 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few fine roots; common very fine tubular pores; less than 5 percent basalt pebbles; mycelial lime; violently effervescent; moderately alkaline; abrupt smooth boundary.

IIR-33 inches; lime- and silica-coated basalt.

Depth to basalt is 20 to 40 inches. The A horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is neutral to moderately alkaline. The B horizon has value of 5 or 6 when dry. The C horizon is mildly alkaline or moderately alkaline. It is 0 to 10 percent coarse basalt fragments and is silt loam or very fine sandy loam.

Quincy series

The Quincy series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in eolian sand. Slopes range from 0 to 10 percent. Elevation is 650 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 135 to 180 days.

Typical pedon of Quincy loamy fine sand, 0 to 10 percent slopes, about 4 miles southeast of Sunnyside, about 1,320 feet north and 50 feet west of the southeast corner of sec. 34, T. 10 N., R. 23 E.

A1-0 to 20 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; few very fine roots; neutral; gradual wavy boundary.

C2-20 to 60 inches; grayish brown (10YR 5/2) sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; mildly alkaline.

The 10- to 40-inch control section is sand to loamy fine sand. The profile has value of 4 or 5 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. The A horizon is slightly acid to moderately alkaline. The C horizon is neutral to moderately alkaline.

Renslow series

The Renslow series consists of deep and very deep, well drained soils on uplands. These soils formed in loess. Elevation is 2,500 to 2,800 feet. Slopes range from 0 to 15 percent. The average annual precipitation is 10 to 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Renslow silt loam, basalt substratum, 5 to 15 percent slopes, about 13 miles southwest of Mabton, about 2,400 feet west and 1,200 feet north of the southeast corner of sec. 35, T. 7 N., R. 21 E.

Ap-0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; very few fine roots; neutral; abrupt smooth boundary.

B1-7 to 23 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate coarse prismatic structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; common fine pores; mildly alkaline; abrupt smooth boundary.

B2t-23 to 30 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; moderate coarse prismatic structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; common fine pores; thin patchy clay films on faces of peds; moderately alkaline; abrupt smooth boundary.

C1-30 to 33 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; moderately alkaline; abrupt wavy boundary.

C2-33 to 37 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine roots; few fine pores; 10 percent pebbles; violently effervescent; moderately alkaline; abrupt wavy boundary.

C3ca-37 to 44 inches; pale brown (10YR 6/3) gravelly silt loam, brown (10YR 4/3) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine roots; few fine pores; 20 percent pebbles; mycelial lime; violently effervescent; moderately alkaline; abrupt smooth boundary.

IIR-44 inches; basalt.

Depth to secondary carbonates is 25 to 40 inches. Depth to basalt is 40 to 60 inches or more. The mollic epipedon is 10 to 18 inches thick.

The Ap horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist. It is neutral or mildly alkaline.

The B horizon has value of 4 or 5 when dry.

The C horizon has value of 5 or 6 when dry and 3 or 4 when moist. It is moderately alkaline or strongly alkaline.

Ritzville series

The Ritzville series consists of deep and very deep, well drained soils on uplands. These soils formed in loess. Slopes range from 0 to 60 percent. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Ritzville silt loam, 2 to 5 percent slopes, about 7 miles southwest of Mabton, about 3,700 feet west and 75 feet south of the northeast corner of sec. 4, T. 7 N., R. 23 E.

Ap-0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; neutral; abrupt smooth boundary.

B2-7 to 26 inches; brown (10YR 5/3) silt loam, very dark brown (10YR 3/3) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; mildly alkaline; gradual wavy boundary.

B3-26 to 37 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; mildly alkaline; gradual wavy boundary.

C2ca-37 to 52 inches; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; mycelial lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C3ca-52 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, friable, slightly sticky and slightly plastic; few very fine roots; common fine pores; disseminated lime; strongly effervescent; moderately alkaline.

The mollic epipedon is 10 to 15 inches thick. Depth to secondary carbonates ranges from 30 to 43 inches. The Ap horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry. The B horizon has chroma of 3 or 4 when dry or moist. The C horizon has value of 5 or 6 when dry and 4 or 5 when moist. It is moderately alkaline or strongly alkaline.

Ritzville Variant

The Ritzville Variant consists of very deep, well drained soils on terraces. These soils formed in loess overlying cobbly or gravelly alluvium. Slopes range from 5 to 15 percent. Elevation is 1,200 to 1,800 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Ritzville Variant silt loam, 5 to 15 percent slopes, about 9 miles northeast of Sunnyside, about 2,030 feet north and 820 feet west of the southeast corner of sec. 16, T. 11 N., R. 23 E.

Ap1-0 to 3 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary.

Ap2-3 to 7 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak thick platy structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary.

B2-7 to 18 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; 10 percent pebbles; mildly alkaline; abrupt smooth boundary.

IIC1-18 to 28 inches; pale brown (10YR 6/3) gravelly silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; 20 percent pebbles; mildly alkaline; abrupt smooth boundary.

IIC2-28 to 36 inches; pale brown (10YR 6/3) very cobbly silt loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; many fine roots; 30 percent cobbles and 10 percent pebbles; slightly effervescent; mildly alkaline; clear wavy boundary.

IIC3ca-36 to 39 inches; pale brown (10YR 6/3) very cobbly loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; many fine roots; 30 percent cobbles and 10 percent pebbles; segregated and disseminated lime; violently effervescent; moderately alkaline; abrupt wavy boundary.

IIC4ca-39 to 60 inches; light gray (10YR 7/2) very cobbly loam, dark grayish brown (10YR 4/2) moist; massive; very hard, firm, nonsticky and slightly plastic; few fine roots; 30 percent cobbles and 10 percent pebbles; lime coatings on coarse fragments; violently effervescent; moderately alkaline.

The mollic epipedon is 8 to 15 inches thick. The Ap horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist. It is silt loam or cobbly silt loam. The B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when dry or moist. The IIC horizon has value of 5 to 7 when dry and 4 or 5 when moist.

Rock Creek series

The Rock Creek series consists of very shallow and shallow, well drained soils on plateaus and ridgetops on uplands. These soils formed in loess and in residuum derived from basalt. Slopes range from 0 to 45 percent. Elevation is 1,200 to 3,200 feet. The annual precipitation is 10 to 16 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 170 days.

Typical pedon of Rock Creek very stony silt loam, 0 to 30 percent slopes, about 400 feet west and 75 feet north of the southeast corner of sec. 1, T. 15 N., R. 17 E.

A1-0 to 2 inches; grayish brown (10YR 5/2) very stony silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine and few fine roots; stones on 3 percent of surface; 15 percent pebbles and 10 percent cobbles; neutral; clear smooth boundary.

B21t-2 to 4 inches; brown (10YR 5/3) very cobbly clay, dark brown (10YR 3/3) moist; moderate thin platy structure; slightly hard, friable, sticky and plastic; common very fine and few fine roots; few fine tubular pores; few thin patchy clay films on faces of peds; 20 percent pebbles and 20 percent cobbles; neutral; abrupt smooth boundary.

B22t-4 to 10 inches; brown (7.5YR 5/4) very cobbly clay, dark brown (7.5YR 3/4) moist; moderate medium angular blocky structure; hard, firm, sticky and plastic; thick continuous clay films on faces of peds; few dark organic stains on faces of peds; 30 percent pebbles and 20 percent cobbles; neutral; clear smooth boundary.

R-10 inches; fractured basalt.

Depth to basalt ranges from 8 to 15 inches. The control section is 35 to 45 percent clay and 35 to 90 percent coarse fragments. The profile is neutral or Slightly acid. The A horizon has hue of 5YR to 10YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 or 3 when dry or moist. The B2t horizon has hue of 5YR or 7.5YR, and it has value of 4 or 5 when dry. It is silty clay loam, clay loam, silty clay, or clay and is extremely cobbly, extremely gravelly, very cobbly, or very gravelly.

Roza series

The Roza series consists of very deep, well drained soils on uplands. These soils formed in material derived from fine textured sediment. Slopes range from 5 to 60 percent. Elevation is 1,300 to 2,400 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 150 days.

Typical pedon of Roza clay loam, 8 to 15 percent slopes, about 4 miles north of Selah, about 300 feet east and 120 feet south of the northwest corner of sec. 14, T. 14 N., R. 18 E.

A11-0 to 2 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; strong fine and very fine granular structure; soft, firm, sticky and plastic; common very fine roots; common very fine tubular pores; mildly alkaline; abrupt wavy boundary.

B21-2 to 11 inches; grayish brown (10YR 5/2) heavy clay loam, dark grayish brown (10YR 4/2) moist; moderate coarse prismatic structure parting to moderate coarse angular blocky; very hard, firm, sticky and plastic; vertical cracks between peds; common very fine roots; many fine and very fine tubular pores; mildly alkaline; abrupt wavy boundary.

B22-11 to 19 inches; light brownish gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; strong medium prismatic structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; vertical cracks between peds; few very fine roots; many fine and very fine tubular pores; mildly alkaline; abrupt wavy boundary.

C1-19 to 26 inches; light brownish gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; weak coarse prismatic structure; hard, firm, sticky and plastic; few very fine roots; common fine and very fine tubular pores; mildly alkaline; clear wavy boundary.

C2-26 to 38 inches; pale brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, firm, sticky and plastic; few very fine roots; common fine and very fine tubular pores; moderately alkaline; abrupt wavy boundary.

C3ca-38 to 45 inches; pale brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; very hard, firm, sticky and plastic; few very fine roots; common fine tubular pores; mycelial lime; violently effervescent; moderately alkaline; clear wavy boundary.

C4ca-45 to 60 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; weakly laminated; very hard, very firm, sticky and plastic; mycelial lime and coatings of lime on laminations; violently effervescent; moderately alkaline.

Depth to calcareous material is 36 to 60 inches. The solum is 16 to 26 inches thick. The profile is 0 to 5 percent rock fragments throughout. The control section is 35 to 60 percent clay. Vertical cracks 1 centimeter to 2 centimeters wide extend from the surface to a depth of 19 inches. The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 1 or 2 when dry or moist. The B2 horizon is heavy clay loam, heavy silty clay loam, silty clay, or clay. The C horizon is silty clay loam, silty clay, or clay loam.

Sapkin series

The Sapkin series consists of moderately deep, well drained soils on uplands and mountainsides. These soils formed in loess and in residuum and colluvium derived dominantly from basalt. Slopes range from 10 to 75 percent. Elevation is 2,800 to 5,600 feet. The average annual precipitation is 18 to 35 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season 'is 95 to 130 days.

Typical pedon of Sapkin very stony loam, 10 to 45 percent slopes, about 6 miles northeast of Naches, about 100 feet east and 900 feet south of the northwest corner of sec. 14, T. 15 N., R. 16 E.

A11-0 to 7 inches; dark grayish brown (10YR 4/2) very stony loam, very dark brown (10YR 2/2) moist; moderate medium and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and few coarse roots; stones on 15 percent of surface; slightly acid; clear wavy boundary.

A12-7 to 15 inches:, brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and coarse roots; 10 percent pebbles; slightly acid; clear wavy boundary.

B1-15 to 27 inches; brown (7.5YR 5/4) cobbly loam, dark brown (7.5YR 4/4) gravelly loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine roots; few fine tubular pores; 20 percent pebbles and 15 percent cobbles; slightly acid; clear wavy boundary.

B21t-27 to 31 inches; brown (7.5YR 5/4) very cobbly loam, dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few fine roots; common fine tubular pores; few thin clay films on faces of peds; 20 percent cobbles and 15 percent pebbles:, slightly acid; clear wavy boundary.

B22t-31 to 35 inches; brown (7.5YR 5/4) extremely cobbly clay loam, dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; hard, firm, sticky and plastic; very few fine roots; few fine tubular pores; few thin clay films on faces of peds; 70 percent cobbles and 20 percent pebbles; slightly acid; abrupt wavy boundary.

R-35 inches; basalt.

Depth to basalt is 20 to 40 inches. The mollic epipedon is 10 to 18 inches thick. The control section is 40 to 80 percent rock fragments. The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 or 3 when moist. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. It is extremely cobbly loam, very cobbly loam, extremely cobbly clay loam, or very cobbly clay loam.

Saydab series

The Saydab series consists of moderately deep, moderately well drained soils on mountaintops and broad ridgetops. These soils formed in residuum derived dominantly from basalt and containing volcanic ash and loess. Slopes range from 0 to 5 percent. Elevation is 5,500 to 7,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is about 41 degrees F, and the average length of the growing season, at 28 degrees F, is 80 to 110 days.

Typical pedon of Saydab cobbly loam, 0 to 5 percent slopes, about 11 miles west of Tampico, about 2,300 feet west and 660 feet south of the northeast corner of sec. 5, T. 12 N., R. 14 E.

O1-1 inch to 0; decomposing forest litter.

A11-0 to 5 inches; dark brown (10YR 4/3) cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common coarse roots and many very fine, fine, and medium roots; 5 percent pebbles and 10 percent cobbles; medium acid; abrupt wavy boundary.

A12-5 to 11 inches; dark brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few coarse roots and common medium and very fine roots; 5 percent pebbles; medium acid; clear smooth boundary.

B2-11 to 15 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine and medium roots; 10 percent pebbles, 35 percent cobbles, and 5 percent stones; medium acid; clear wavy boundary.

B3-15 to 27 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and medium roots; 10 percent pebbles, 40 percent cobbles, and 5 percent stones; medium acid; abrupt wavy boundary.

R-27 inches; basalt.

Depth to bedrock is 25 to 30 inches. The control section is 40 to 60 percent rock fragments. The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist. The B horizon has value of 3 or 4 when moist, and it has chroma of 3 or 4 when dry. It is very cobbly loam or very cobbly silt loam.

Scoon series

The Scoon series consists of shallow, well drained soils on uplands. These soils formed in loess overlying a lime- and silica-cemented duripan. Slopes range from 2 to 30 percent. Elevation is 800 to 1,400 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typical pedon of Scoon silt loam, 5 to 8 percent slopes, about 5 miles north of Sunnyside, about 200 feet west and 1,100 feet south of the northeast corner of sec. 36, T. 11 N., R. 22 E.

Ap-0 to 6 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; 5 percent pebbles; mildly alkaline; abrupt smooth boundary.

B2-6 to 10 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; 15 percent pebbles; moderately alkaline; gradual wavy boundary.

C1ca-10 to 16 inches; light brownish gray (10YR 6/2) gravelly silt loam, dark grayish brown (10YR 4/2) moist; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; 30 percent pebbles; violently effervescent; moderately alkaline; abrupt wavy boundary.

IIC2casim-16 to 60 inches; indurated lime- and silica-cemented duripan.

Depth to the duripan is 10 to 20 inches. The duripan is underlain by basalt at a depth of 20 inches or more. The control section averages less than 35 percent rock fragments.

The A horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is 0 to 5 percent rock fragments and is mildly alkaline or moderately alkaline.

The B2 horizon has value of 6 or 7 when dry and 4 or 5 when moist, and it has chroma of 2 or 3 when dry or moist. It is gravelly silt loam, silt loam, or gravelly very fine sandy loam. It is mildly alkaline or moderately alkaline.

The C horizon has value of 6 or 7 when dry and 4 or 5 when moist. It is gravelly silt loam, loam, or gravelly very fine sandy loam.

Scooteney series

The Scooteney series consists of very deep, well drained soils on terraces. These soils formed in alluvium. Slopes range from 0 to 15 percent. Elevation is 650 to 1,300 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 170 days.

Typical pedon of Scooteney silt loam, 0 to 2 percent slopes, about 1 mile northeast of Mabton, about 600 feet north and 50 feet west of the southeast corner of sec. 31, T. 9 N., R. 23 E.

Ap-0 to 6 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many fine roots; many fine pores; neutral; abrupt smooth boundary.

B2-6 to 22 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, friable, nonsticky and slightly plastic; many fine roots; many fine pores; neutral; gradual wavy boundary.

C1ca-22 to 33 inches; light brownish gray (10YR 6/2) gravelly fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; 20 percent pebbles; violently effervescent; moderately alkaline; gradual wavy boundary.

IIC2-33 to 60 inches; light brownish gray (10YR 6/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, friable, nonsticky and nonplastic; few fine roots; few pores; 50 percent pebbles; moderately alkaline.

The control section averages 20 to 35 percent coarse fragments. The A horizon has chroma of 2 or 3 when moist or dry. It is silt loam or cobbly silt loam.

The B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is silt loam, loam, or very fine sandy loam. It is neutral or mildly alkaline.

The C horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 2 or 3 when moist or dry. It is gravelly fine sandy loam or gravelly silt loam.

Selah series

The Selah series consists of moderately deep, well drained soils on high, dissected terraces. These soils formed in loess and alluvium overlying a lime- and silica-cemented duripan. Slopes range from 2 to 30 percent. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 180 days.

Typical pedon of Selah silt loam, 5 to 8 percent slopes, about 1 mile northwest of Selah, about 1,400 feet west and 700 feet north of the southeast corner of sec. 26, T. 14 N., R. 18 E.

Ap-0 to 4 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; few fine tubular pores; neutral; abrupt smooth boundary.

A12-4 to 7 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; few fine tubular pores; neutral; clear wavy boundary.

B1-7 to 13 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; mildly alkaline; clear wavy boundary.

B21t-13 to 24 inches; pale brown (10YR 6/3) heavy silt loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many fine tubular pores; thin patchy siliceous coatings on faces of peds; mildly alkaline; clear wavy boundary.

B22t-24 to 29 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common fine tubular pores; few thin patchy Clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

B22tca-29 to 34 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; strong medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; common thin clay films on faces of peds and in pores; lime on faces of peds and in veins throughout peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

IIC2casim-34 inches; indurated lime- and silica-cemented duripan.

Depth to the duripan is 20 to 40 inches. The duripan is 6 to 24 inches thick and overlies old gravelly alluvial material, tuffaceous sandstone, or basalt. The mollic epipedon is 7 to 15 inches thick. The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. The B2t horizon is heavy silt loam, clay loam, or silty clay loam. The B2tca horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist or dry. It is clay loam or silty clay loam.

Shano series

The Shano series consists of very deep, well drained soils on uplands. These soils formed in loess. Slopes range from 2 to 30 percent. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

Typical pedon of Shano silt loam, 8 to 15 percent slopes, about 5 miles southwest of Mabton, about 1,800 feet north and 130 feet west of the southeast corner of sec. 27, T. 8 N., R. 22 E.

A1-0 to 4 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; moderate thin platy structure; soft, friable, nonsticky and nonplastic; many very fine and common fine roots; mildly alkaline; abrupt smooth boundary.

B2-4 to 20 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak medium prismatic structure parting to weak medium angular blocky; soft, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; very fine tubular pores; mildly alkaline; gradual smooth boundary.

B3-20 to 30 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; mildly alkaline; abrupt smooth boundary.

C2ca-30 to 43 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, firm, slightly sticky and slightly plastic; few fine and common very fine roots; few very fine tubular pores; segregated lime in root channels; slightly effervescent; strongly alkaline; clear wavy boundary.

C3-43 to 60 inches; pale brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) moist; massive; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; strongly effervescent; strongly alkaline.

Depth to secondary carbonates is 24 to 40 inches. The A horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is neutral to moderately alkaline. The B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is mildly alkaline or moderately alkaline. The C horizon has value of 6 or 7 when dry.

Simcoe series

The Simcoe series consists of moderately deep, well drained soils on uplands. These soils formed in loess and in residuum derived from basalt and contain a small amount of volcanic ash. Slopes range from 5 to 30 percent. Elevation is 1,200 to 2,300 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 170 days.

Typical pedon of a Simcoe silt loam (5 to 15 percent slopes), in an area of Rock Creek-Clint-Simcoe complex, 0 to 45 percent slopes, about 4 miles west of Fruitvale, about 1,620 feet south and 2,340 feet west of the northeast corner of sec. 13, T. 13 N., R. 17 E.

A1-0 to 3 inches; brown (7.5YR 4/4) silt loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 10 percent pebbles; neutral; clear wavy boundary.

B1-3 to 14 inches; brown (7.5YR 4/4) silt loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; soft, friable, slightly sticky and plastic; common fine roots; many very fine tubular pores; 5 percent pebbles; neutral; clear wavy boundary.

B22t-14 to 27 inches; brown (7.5YR 4/4) heavy silt loam, dark brown (7.5YR 3/2) moist; strong medium angular blocky structure; slightly hard, firm, sticky and plastic; common fine roots; common very fine vesicular pores; common thin clay films on faces of peds; 10 percent pebbles; mildly alkaline; abrupt wavy boundary.

R-27 inches; basalt.

Depth to basalt is 20 to 40 inches. The mollic epipedon is 10 to 20 inches thick. The A horizon has hue of 10YR or 7.5YR, and it has value of 4 or 5 when dry and 2 or 3 when moist. The B2t horizon has hue of 10YR or 7.5YR, and it has value of 4 to 6 when dry and 3 or 4 when moist. It is heavy silt loam, silty clay loam, or clay loam and is 0 to 15 percent coarse fragments.

Sinloc series

The Sinloc series consists of very deep, somewhat poorly drained soils on terraces. These soils formed in lacustrine sediment that has a mantle of loess. Slopes range from 0 to 8 percent. Elevation is 650 to 1,200 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 180 days.

Typical pedon of Sinloc silt loam, 2 to 5 percent slopes, about 3 miles west of Outlook, about 1,600 feet north and 340 feet west of the southeast corner of sec. 24, T. 10 N., R. 21 E.

A11-0 to 1/2 inch; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; salt incrustations on the surface and on faces of peds; violently effervescent; strongly alkaline; abrupt smooth boundary.

A12-1/2 inch to 3 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; violently effervescent; strongly alkaline; abrupt smooth boundary.

B2-3 to 15 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; violently effervescent; strongly alkaline; abrupt smooth boundary.

C1ca-15 to 31 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5YR 6/2) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine roots; threadlike veins of lime; violently effervescent; strongly alkaline; abrupt wavy boundary.
C2-31 to 35 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; soft, friable, nonsticky and nonplastic; common very fine roots; violently effervescent; strongly alkaline; abrupt *wavy* boundary.
C3-35 to 45 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; violently effervescent; moderately alkaline; abrupt wavy boundary.
C4-45 to 60 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; thin lenses of silt loam; slightly effervescent; moderately alkaline.

The profile is moderately alkaline or strongly alkaline. The solum is 15 to 30 inches thick.

The A horizon has value of 3 or 4 when moist and 5 or 6 when dry. It is silt loam or fine sandy loam.

The B horizon has value of 3 or 4 when moist and 5 or 6 when dry. It is silt loam or very fine sandy loam.

The C horizon has value of 4 or 5 when moist, and it has chroma of 1 or 2 when dry or moist. Between depths of 15 and 40 inches the C horizon is silt loam or very fine sandy loam, is less than 15 percent sand that is fine or coarse, and is less than 18 percent clay. Below a depth of 40 inches it is silt loam, sandy loam, or loamy fine sand.

Starbuck series

The Starbuck series consists of shallow, well drained soils on uplands. These soils formed in loess overlying basalt. Slopes range from 0 to 60 percent. Elevation is 700 to 2,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 170 days.

Typical pedon of Starbuck silt loam, 2 to 15 percent slopes, about 1/2 mile north of Byron, about 2,800 feet east and 3,500 feet south of the northwest corner of sec. 12, T. 8 N., R. 23 E.

A11-0 to 3 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak thin platy structure; soft, very friable, nonsticky and slightly plastic; many fine roots; many very fine tubular pores; neutral; clear smooth boundary.
A12-3 to 6 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium platy structure; soft, very friable, nonsticky and slightly plastic; common very fine roots; many very fine tubular pores; neutral; clear wavy boundary.
B21-6 to 9 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 10 percent pebbles; neutral; clear smooth boundary.
B22-9 to 16 inches; pale brown (10 Y R 6/3) gravelly silt loam, dark brown (10YR 3/3) moist; weak medium prismatic structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 20 percent pebbles; neutral; abrupt smooth boundary.
R-16 inches; basalt.

Depth to basalt is 12 to 20 inches. The control section is 5 to 25 percent coarse fragments. The profile is neutral or mildly alkaline. The A horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist. The B2 horizon has value of 5 or 6 when dry, and it has chroma of 3 or 4 when dry or moist. It is gravelly silt loam, loam, or fine sandy loam.

Sutkin series

The Sutkin series consists of very deep, well drained soils on mountainsides, on smooth mountaintops, and in canyons. These soils formed in colluvium and residuum derived dominantly from basalt and containing a small amount of loess. Slopes range from 0 to 65 percent. Elevation is 2,400 to 4,800 feet. The average annual precipitation is 18 to 22 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typical pedon of Sutkin stony loam, 0 to 25 percent slopes, about 6 miles west of Tampico, about 1,100 feet west and 2,300 feet south of the northeast corner of sec. 14, T. 12 N., R. 14 E.

O1&O2-1/2 inch to 0; decomposing forest litter.
A1-0 to 10 inches; dark brown (10YR 3/3) stony loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine and common coarse roots; 5 percent stones; slightly acid; clear wavy boundary.
B1-10 to 20 inches; dark yellowish brown (10YR 4/4) very cobbly loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common coarse and many fine roots; 30 percent pebbles and 20 percent cobbles; neutral; clear irregular boundary.

B2-20 to 38 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common coarse and many fine roots; 35 percent pebbles and 35 percent cobbles; neutral; clear wavy boundary.
C-38 to 60 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and plastic; common fine and coarse roots; 30 percent pebbles and 40 percent cobbles; neutral.

The mollic epipedon is 10 to 18 inches thick. The control section averages 40 to 60 percent rock fragments and 18 to 30 percent clay.

The A horizon has value of 3 or 4 when dry and 2 or 3 when moist, and it has chroma of 3 or 4 when dry and 1 to 3 when moist.

The B2 horizon has value of 4 to 6 when dry, and it has chroma of 3 or 4 when moist. It is extremely cobbly loam, very gravelly loam, or very cobbly loam.

The C horizon has value of 3 or 4 when moist, and it has chroma of 3 or 4 when moist. It is extremely cobbly loam or very cobbly clay loam.

Sutkin Variant

The Sutkin Variant consists of very deep, well drained soils on alluvial fans. These soils formed in loess overlying cobbly or gravelly alluvium. Slopes range from 0 to 5 percent. Elevation is 2,400 to 2,600 feet. The average annual precipitation is 14 to 17 inches, the average annual air temperature is about 48 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 170 days.

Typical pedon of Sutkin Variant stony loam, 0 to 5 percent slopes, about 12 miles northwest of Naches, about 750 feet west and 40 feet north of the southeast corner of sec. 15, T. 16 N., R. 16 E.

O1-1/2 inch to 0; decomposing forest litter.
A1-0 to 8 inches; grayish brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; many fine roots and common coarse roots; 5 percent stones; neutral; clear wavy boundary.
B1-8 to 14 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine roots and common coarse roots; 20 percent pebbles; neutral; clear wavy boundary.
B2-14 to 18 inches; pale brown (10YR 6/3) very gravelly loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots and common coarse roots; 40 percent pebbles; neutral; clear wavy boundary.
C-18 to 60 inches; pale brown (10YR 6/3) extremely gravelly sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots and common coarse roots; 70 percent pebbles; neutral.

The mollic epipedon is 10 to 16 inches thick. The control section averages 40 to 60 percent coarse fragments.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 to 3 when moist.

The B2 horizon has chroma of 3 or 4 when dry or moist. It is very cobbly loam or very gravelly loam.

The C horizon has value of 4 to 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist. It is very gravelly sandy loam or extremely gravelly sandy loam.

Taneum series

The Taneum series consists of very deep, well drained soils on uplands. These soils formed in loess overlying material weathered from sandstone. Slopes range from 5 to 60 percent. Elevation is 2,300 to 3,000 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 135 days.

Typical pedon of Taneum loam, 5 to 15 percent slopes, about 6 miles west of Cowiche, about 2,000 feet west and 20 feet south of the northeast corner of sec. 29, T. 14 N., R. 16 E.

A11-0 to 4 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; neutral; abrupt wavy boundary.
A12-4 to 10 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt wavy boundary.
A3-10 to 14 inches; grayish brown (19YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

B22t-14 to 27 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine tubular pores; thin patchy clay films on faces of peds; neutral; clear wavy boundary.

B23t-27 to 43 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 3/4) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine tubular pores; thin patchy clay films on faces of peds; neutral; clear wavy boundary.

C1-43 to 50 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; common fine tubular pores; neutral; abrupt wavy boundary.

C2-50 to 60 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; massive; hard, friable, nonsticky and nonplastic; common fine tubular pores; neutral.

The mollic epipedon is 12 to 19 inches thick. The control section is 27 to 35 percent clay, is more than 15 percent sand that is fine or coarser, and is less than 15 percent rock fragments. The B horizon has hue of 10YR or 7.5YR.

Tekison series

The Tekison series consists of very deep, well drained soils on mountainsides, mountain ridges and benches, and smooth mountaintops. These soils formed in residuum and colluvium derived from basalt and containing a small amount of loess. Slopes range from 0 to 25 percent. Elevation is 2,800 to 3,600 feet. The average annual precipitation is 16 to 20 inches, the average annual air temperature is about 47 degrees F, and the average length of the growing season, at 28 degrees F, is 150 to 170 days.

Typical pedon of Tekison stony loam, 0 to 25 percent slopes, about 5 miles northwest of Tampico, about 150 feet east and 900 feet north of the southwest corner of sec. 27, T. 13 N., R. 15 E.

A1-0 to 4 inches; brown (10YR 4/3) stony loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; few fine and many very fine tubular pores; 5 percent stones; neutral; abrupt smooth boundary.

B1-4 to 12 inches; brown (10YR 4/3) stony loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; hard, firm, slightly sticky and plastic; common fine roots; few fine and many very fine tubular pores; 10 percent stones and 15 percent pebbles; slightly acid; clear smooth boundary.

B21t-12 to 20 inches; brown (10YR 5/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate medium angular blocky structure; hard, very firm, sticky and very plastic; few fine and medium roots; common very fine tubular pores; common moderately thick clay films on faces of peds; 20 percent pebbles and 20 percent cobbles; slightly acid; gradual wavy boundary.

B22t-20 to 31 inches; yellowish brown (10YR 5/4) very gravelly clay, dark yellowish brown (10YR 4/4) moist; moderate medium angular blocky structure; hard, very firm, very sticky and very plastic; ; few very fine roots; common very fine tubular pores; many thick clay films on faces of peds; 30 percent pebbles and 10 percent cobbles; slightly acid; gradual wavy boundary.

B23t-31 to 60 inches; brown (10YR 5/3) very cobbly clay, dark brown (10YR 3/3) moist; strong fine and medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; common very fine tubular pores; continuous thick clay films on faces of peds; 25 percent pebbles and 15 percent cobbles; slightly acid.

The mollic epipedon is 10 to 18 inches thick. The control section is 40 to 50 percent rock fragments. The A horizon has value of 4 or 5 when dry, and it has chroma of 2 or 3 when moist. The B2t horizon has chroma of 2 to 4 when dry or moist. It is very cobbly clay loam, very gravelly clay, or very cobbly clay.

Tieton series

The Tieton series consists of deep, well drained soils on uplands. These soils formed in loess and in material weathered from andesite. Slopes range from 0 to 30 percent. Elevation is 1,500 to 2,300 feet. The average annual precipitation is 11 to 15 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 135 to 150 days.

Typical pedon of Tieton loam, 2 to 5 percent slopes, about 1 mile northeast of Cowiche, about 1,300 feet south and 900 feet east of the northwest corner of sec. 22, T. 14 N., R. 17 E.

Ap-0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

A12-3 to 9 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few fine tubular pores; neutral; clear wavy boundary.

B1-9 to 15 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few fine tubular pores; neutral; clear wavy boundary.

B21t-15 to 31 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; few fine roots; few fine tubular pores; siliceous coatings on faces of peds; neutral; clear wavy boundary.

B22t-31 to 37 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; hard, firm, slightly sticky and plastic; few fine roots; few fine tubular pores; neutral; abrupt smooth boundary.

B23t-37 to 44 inches; brown (10YR 5/3) clay loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; thin discontinuous clay films on faces of peds and in pores; neutral; clear wavy boundary.

C1-44 to 48 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; 5 percent fragments of andesite; lime coatings on upper boundary; neutral; abrupt smooth boundary.

Crca-48 to 50 inches; light yellowish brown (2.5Y 6/4) weathered andesite, olive brown (2.5Y 4/4) moist; massive; hard, firm; lime coatings on upper boundary; neutral; abrupt smooth boundary.

IIR-50 inches; andesite.

The mollic epipedon is 10 to 16 inches thick. The control section is 27 to 35 percent clay. Depth to weathered andesite ranges from 40 to 60 inches. The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. It is loam or fine sandy loam. The B horizon has value of 4 to 6 when dry and 3 or 4 when moist. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 3 or 4 when dry or moist. It is loam or clay loam.

Toppenish series

The Toppenish series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 2 percent. Elevation is 700 to 1,800 feet. The average annual precipitation is 8 to 10 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Toppenish silt loam, about 3 miles southeast of Yakima, about 1,400 feet east and 2,600 feet south of the northwest corner of sec. 33, T. 13 N., R.19E.

Ap-0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; many fine and common medium roots; common very fine vesicular pores; violently effervescent; strongly alkaline; abrupt smooth boundary.

B1-4 to 14 inches; gray (10YR 5/1) silty clay loam, black (10YR 2/1) moist; moderate medium angular blocky structure; slightly hard, friable, sticky and plastic; common fine and few medium roots; common very fine vesicular pores; violently effervescent; strongly alkaline; clear wavy boundary.

IIB21g-14 to 35 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; common medium distinct mottles that are yellowish brown (10YR 5/6) when moist; slightly hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; common very fine vesicular pores and few fine tubular pores; moderately alkaline; gradual wavy boundary.

IIIB22-35 to 50 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; many medium distinct mottles that are yellowish brown (10YR 5/6) when moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and few medium roots; common very fine vesicular pores; 5 percent pebbles; mildly alkaline; clear smooth boundary.

IVC1-50 to 60 inches; brown (10YR 5/3) extremely gravelly sand, very dark grayish brown (10YR 3/2) moist; massive; loose; few very fine and medium roots; 60 percent pebbles; mildly alkaline.

The mollic epipedon is 10 to 20 inches thick. The IVC horizon is at a depth of 40 inches or more. The profile is mildly alkaline to strongly alkaline.

The A and B1 horizons have value of 2 or 3 when moist.

The B2g horizon has value of 4 or 5 when dry and 3 or 4 when moist, and it has chroma of 1 or 2 when dry or moist. It has distinct or prominent mottles. This horizon is silt loam, loam, or clay loam and averages 20 to 30 percent clay.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 when dry, and chroma of 2 to 4 when dry or moist. It is extremely gravelly sandy loam or extremely gravelly sand.

Track series

The Track series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in mixed alluvium. Slopes range from 0 to 2 percent. Elevation is 800 to 1,500 feet. The average annual precipitation is 8 to 10 inches, the average annual air

temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Track loam, about 1 mile east of Union Gap, about 1,500 feet west and 100 feet south of the northeast corner of sec. 4, T. 12 N., R. 19 E.

A11-0 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine pores; 0 to 5 percent pebbles; disseminated carbonates; violently effervescent; strongly alkaline; abrupt smooth boundary.

IIB21g-14 to 21 inches; grayish brown (10YR 5/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; 50 percent pebbles and 10 percent cobbles; disseminated carbonates and filaments of segregated carbonates; violently effervescent; strongly alkaline; abrupt wavy boundary.

IIB22-21 to 26 inches; brown (10YR 5/3) very gravelly loam, very dark grayish brown (10YR 3/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 40 percent pebbles and 10 percent cobbles; moderately alkaline; abrupt wavy boundary.

IIC1-26 to 60 inches; brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 3/3) moist; many fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; 40 percent pebbles and 10 percent cobbles; moderately alkaline.

The control section averages 45 to 65 percent coarse fragments. The mollic epipedon is 10 to 20 inches thick. The IIC horizon is at a depth of 20 to 30 inches.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 or 2 when dry or moist. It is mildly alkaline to strongly alkaline.

The IIB horizon has value of 4 or 5 when dry and 2 or 3 when moist. It is moderately alkaline or strongly alkaline.

The C horizon has value of 4 or 5 when dry and 3 or 4 when moist, and it has chroma of 1 to 3 when dry or moist. It has distinct or prominent mottles. The horizon is very gravelly sand or very gravelly loamy sand and is moderately alkaline or strongly alkaline.

Tumac series

The Tumac series consists of very deep, well drained soils on south-facing uplands and mountainsides. These soils formed in colluvium derived from basalt and andesite and containing volcanic ash. Slopes range from 5 to 45 percent. Elevation is 4,100 to 5,200 feet. The average annual precipitation is 30 to 60 inches, the average annual air temperature is about 43 degrees F, and the average length of the growing season, at 28 degrees F, is 145 to 170 days.

Typical pedon of Tumac very stony sandy loam, 5 to 45 percent slopes, about 20 miles west of Tampico, about 200 feet east and 100 feet south of the northwest corner of sec. 27, T. 12 N., R. 12 E.

O1-2 inches to 0; decomposing forest litter.

A11-0 to 4 inches; brown (10YR 5/3) very stony sandy loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine and common fine roots; 10 percent stones; medium acid; abrupt wavy boundary.

A12-4 to 15 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots; 40 percent pebbles; medium acid; abrupt wavy boundary.

B21-15 to 30 inches; yellowish brown (10YR 5/4) very gravelly loam, dark brown (7.5YR 3/4) moist; common very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and common fine roots; 45 percent pebbles and 5 percent cobbles; medium acid; clear wavy boundary.

B22-30 to 50 inches; yellowish brown (10YR 5/4) extremely gravelly loam, dark yellowish brown (10YR 3/4) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; 55 percent pebbles and 10 percent cobbles; medium acid; clear wavy boundary.

B23-50 to 60 inches; strong brown (7.5YR 5/6) extremely gravelly loam, dark yellowish brown (10YR 3/4) moist; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; 60 percent pebbles and 5 percent cobbles; medium acid.

The control section is 35 to 70 percent rock fragments. The A horizon has chroma of 2 or 3 when moist. The B horizon has chroma of 4 to 6 when moist. It is very gravelly loam, extremely gravelly loam, or very cobbly sandy loam.

Umapine series

The Umapine series consists of very deep, somewhat poorly drained soils on flood plains and low terraces. These soils formed in alluvium. Slopes range from 0 to 5 percent. Elevation is 650 to 900 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Umapine silt loam, 0 to 5 percent slopes, about 3 miles northeast of Mabton, about 2,510 feet north and 660 feet west of the southeast corner of sec. 23, T. 9 N., R. 22 E.

Ap-0 to 7 inches; light brownish gray (2.5Y 6/2) silt loam, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; common fine pores; violently effervescent; very strongly alkaline; abrupt smooth boundary.

C1-7 to 16 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak medium angular blocky structure; hard, friable, sticky and plastic; common fine roots; common fine pores; disseminated lime; violently effervescent; very strongly alkaline; gradual wavy boundary.

C2-16 to 34 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; common fine pores; disseminated lime; slightly effervescent; very strongly alkaline; abrupt smooth boundary.

IIC3-34 to 41 inches; light gray (2.5Y 7/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; disseminated lime; violently effervescent; strongly alkaline; abrupt smooth boundary.

IIIC4-41 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky and plastic; common fine pores; disseminated lime; violently effervescent; strongly alkaline.

In most years the profile is saturated with water to a depth of 40 inches at some time during the year. The profile has hue of 2.5Y or 10YR. The A horizon has value of 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 2 or 3. The C horizon has value of 5 to 7 when dry and 3 to 5 when moist, and it has chroma of 1 or 2.

Wanser series

The Wanser series consists of very deep, poorly drained soils on terraces in basins. These soils formed in sand derived from mixed sources. Slopes range from 0 to 5 percent. Elevation is 650 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of Wanser loamy fine sand, about 2 miles southwest of Sunnyside, about 900 feet west and 1,100 feet north of the southeast corner of sec. 2, T. 9 N., R. 22 E.

Ap-0 to 6 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; single gram loose; many fine roots; moderately alkaline; clear smooth boundary.

C1g-6 to 18 inches; dark grayish brown (10YR 4/2) loamy fine sand, dark gray (5Y 4/1) moist; few fine distinct mottles that are yellowish brown (10YR 5/6) when moist; single grain; loose; many fine roots; moderately alkaline; abrupt wavy boundary.

C2g-18 to 20 inches; grayish brown (10YR 5/2) loamy fine sand, dark bluish gray (5B 4/1) moist; common fine prominent mottles that are bluish gray (5B 6/1) when moist; massive; soft, very friable, nonsticky and nonplastic; few medium roots; slightly effervescent; strongly alkaline; clear smooth boundary.

C3g-20 to 25 inches; grayish brown (10YR 5/2) loamy fine sand, bluish gray (5B 6/1) moist; single grain; loose; few fine roots; strongly alkaline; gradual wavy boundary.

C4g-25 to 57 inches; grayish brown (10YR 5/2) loamy fine sand, bluish gray (5B 5/1) moist; mottles that are dark greenish gray (5Y 4/1) when moist; single grain; loose; few fine roots; strongly alkaline; gradual smooth boundary.

C5g-57 to 60 inches; light brownish gray (10YR 6/2) fine sand, gray (N 5/0) moist; single grain; loose; strongly alkaline.

Where these soils are not artificially drained, the water table fluctuates between the surface and a depth of 12 inches. The profile is moderately alkaline or strongly alkaline. The 10- to 40-inch control section is sand to loamy fine sand. The A horizon has value of 5 or 6 when dry and 3 or 4 when moist. The Cg horizon has value of 3 to 6 when moist.

Warden series

The Warden series consists of very deep, well drained soils on terraces. These soils formed in lacustrine sediment and have a mantle of loess. Slopes range from 0 to 30 percent. Elevation is 600 to 1,000 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 135 to 180 days.

Typical pedon of Warden silt loam, 8 to 15 percent slopes, about 4 miles south of Mabton, about 100 feet

south and 100 feet east of the northwest corner of sec. 26, T. 8 N., R. 22 E.

Ap-0 to 5 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; mildly alkaline; clear smooth boundary.

B2-5 to 19 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine and many very fine roots; many very fine pores; mildly alkaline; abrupt wavy boundary.

IIC1ca-19 to 41 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; massive; hard, very firm, nonsticky and nonplastic; few very fine roots; common very fine tubular pores; disseminated and segregated lime; violently effervescent; strongly alkaline; clear smooth boundary.

IIIC2ca-41 to 60 inches; pale brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) moist; massive; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; disseminated and segregated lime; violently effervescent; strongly alkaline.

The solum is 15 to 30 inches thick. Depth to secondary lime is 15 to 30 inches. The Ap horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is silt loam or very fine sandy loam and is neutral or mildly alkaline. The B horizon is very fine sandy loam or silt loam and is neutral or mildly alkaline. The C horizon has value of 4 or 5 when moist. It is stratified silt loam, loam, and very fine sandy loam, but the 10- to 40-inch control section averages less than 15 percent sand that is fine or coarser.

Weirman series

The Weirman series consists of very deep, somewhat excessively drained soils on low terraces and flood plains. These soils formed in mixed alluvium. Slopes range from 0 to 5 percent. Elevation is 700 to 1,700 feet. The average annual precipitation is 7 to 14 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Weirman sandy loam, channeled, about 3 miles northwest of Buena, about 660 feet south and 220 feet east of the northwest corner of sec. 7, T. 11 N., R. 20 E.

Ap-0 to 8 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable, nonsticky and nonplastic; common fine roots; mildly alkaline; abrupt smooth boundary.

AC-8 to 15 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; few very fine roots; mildly alkaline; abrupt smooth boundary.

C1-15 to 21 inches; light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; few medium faint dark yellowish brown (10YR 4/4) mottles; massive; soft, very friable, nonsticky and slightly plastic; few very fine roots; mildly alkaline; gradual wavy boundary.

IIC2-21 to 60 inches; grayish brown (10YR 5/2) extremely gravelly sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; 75 percent pebbles and 5 percent cobbles; few very fine roots; mildly alkaline.

The profile is neutral or mildly alkaline. The control section averages 35 to 60 percent coarse fragments. The mollic epipedon is 10 to 17 inches thick.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3 when dry or moist. It is fine sandy loam, sandy loam, or gravelly fine sandy loam.

The C horizon has value of 4 or 5 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when moist. It is loamy fine sand, sand, or loamy sand and in places has strata of sandy loam. The IIC horizon is extremely gravelly sand, very gravelly sand, or very gravelly loamy sand.

Wenas series

The Wenas series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 2 percent. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 8 to 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Wenas silt loam, about 4 miles north of Selah, about 400 feet east and 700 feet north of the southwest corner of sec. 12, T. 14 N., R. 18 E.

Ap-0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate coarse granular structure; hard, firm, sticky and plastic; many fine roots; common fine pores; mildly alkaline; abrupt smooth boundary.

B1-8 to 28 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium and fine prismatic structure; hard, firm, sticky and plastic; common fine roots; many fine pores; mildly alkaline; gradual *wavy* boundary.

B2g-28 to 37 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; few fine distinct light yellowish brown (10YR 6/4) mottles; moderate subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many fine pores; neutral; gradual wavy boundary.

C1g-37 to 47 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; common medium prominent brownish yellow (10YR 6/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; common fine roots; common medium pores; neutral; clear wavy boundary.

IIC2g-47 to 55 inches; light brownish gray (2.5Y 6/2) loamy sand, dark grayish brown (2.5Y 4/2) moist; many medium prominent reddish yellow (7.5YR 7/8) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; 5 'percent pebbles; mildly alkaline; abrupt smooth boundary.

IIC3g-55 to 60 inches; light brownish gray (2.5Y 6/2) gravelly loamy sand, dark grayish brown (2.5Y 4/2) moist; few fine faint olive yellow (2.5Y 6/6) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; 20 percent pebbles; mildly alkaline.

The mollic epipedon is 24 to 35 inches thick. The profile is neutral or mildly alkaline. The control section is 0 to 15 percent rock fragments.

The A and B1 horizons have value of 4 or 5 when dry and 2 or 3 when moist. The B1 horizon is silt loam or clay loam.

The B2g horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 1 or 2 when moist or dry. It is clay loam or silty clay loam.

The Cg horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 1 or 2. It is loam or sandy loam.

The IICg horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 1 or 2 when moist or dry.

Wiehl series

The Wiehl series consists of moderately deep, well drained soils on uplands. These soils formed in loess overlying laminated sediment and soft sandstone. Slopes range from 2 to 60 percent. Elevation is 1,000 to 1,200 feet. The annual precipitation is 6 to 9 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typical pedon of a Wiehl silt loam, in an area of Harwood-Burke-Wiehl silt loams, 8 to 15 percent slopes, about 3 miles north of Buena, about 1,620 feet south and 2,340 feet west of the northeast corner of sec. 13, T. 13 N., R. 17 E.

A1-0 to 3 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; many fine roots; common fine pores; neutral; abrupt smooth boundary.

B21-3 to 12 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure; soft, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; neutral; gradual wavy boundary.

B22-12 to 21 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; mildly alkaline; abrupt wavy boundary.

C1-21 to 27 inches; pale brown (10YR 6/3) gravelly silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots matted around pebbles; common fine pores; 20 percent pebbles; violently effervescent; moderately alkaline; abrupt wavy boundary.

IIC2r-27 inches; weathered sandstone.

Depth to the paralithic contact ranges from 20 to 40 inches.

The A horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is silt loam or very stony silt loam and is neutral or mildly alkaline.

The B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. It is fine sandy loam, very fine sandy loam, or silt loam.

The C horizon has value of 6 or 7 when dry and 4 or 5 when moist, and it has chroma of 2 or 3 when dry or moist. It is very fine sandy loam, fine sandy loam, or gravelly silt loam.

Willis series

The Willis series consists of moderately deep, well drained soils on uplands. These soils formed in loess. Slopes range from 0 to 15 percent. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 9 to 12 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 125 to 160 days.

Typical pedon of Willis silt loam, 8 to 15 percent slopes, about 9 miles north of Sunnyside, about 1,500 feet north and 200 feet east of the southwest corner of sec. 1, T. 11 N., R. 22 E.

A11-0 to 3 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots; mildly alkaline; abrupt wavy boundary.

A12-3 to 6 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak fine angular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; few fine tubular pores; mildly alkaline; clear wavy boundary.
B2-6 to 22 inches; brown (10R 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; common fine tubular pores; mildly alkaline; abrupt wavy boundary.
C1-22 to 26 inches; brown (10R 5/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, nonsticky and slightly plastic; common fine roots; few fine tubular pores; slightly effervescent; moderately alkaline; abrupt wavy boundary.
C2ca-26 to 34 inches; pale brown (10YR 6/3) heavy silt loam, brown (10YR 4/3) moist; massive; hard, firm, slightly sticky and plastic; few very fine roots; many fine tubular pores; filaments of lime; violently effervescent; moderately alkaline; abrupt wavy boundary.
C3casim-34 inches; lime- and silica-cemented duripan.

Depth to the duripan is 20 to 40 inches. The duripan is underlain by basalt at a depth of 30 inches or more. The mollic epipedon is 12 to 15 inches thick. The A horizon has value of 4 or 5 when dry and 2 or 3 when moist. The B horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry. The C1 and Cca horizons have value of 5 to 7 when dry and 3 to 5 when moist, and they have chroma of 2 to 4.

Yakima series

The Yakima series consists of very deep, well drained soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 2 percent. Elevation is 700 to 1,200 feet. The average annual precipitation is 9 to 14 inches, the average annual air temperature is about 54 degrees F, and the average frost-free season is 120 to 170 days.

Typical pedon of Yakima silt loam, about 1 mile southwest of Buena, about 2,440 feet east and 1,400 feet north of the southwest corner of sec. 21, T. 11 N., R. 20 E.

Ap-0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak moderate granular structure; hard, friable, slightly sticky and slightly plastic; many fine roots; common fine pores; mildly alkaline; abrupt smooth boundary.
A12-6 to 13 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak moderate granular structure parting to weak moderate subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine pores; mildly alkaline; abrupt smooth boundary.
A13-13 to 17 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10R 3/2) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common fine pores; 10 percent basalt pebbles; mildly alkaline; gradual wavy boundary.
A14-17 to 27 inches; brown (10R 5/3) gravelly very fine sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; few very fine roots; common fine pores; 20 percent basalt pebbles; neutral; gradual wavy boundary.
C1-27 to 30 inches; brown (10R 5/3) gravelly very fine sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common fine pores; 30 percent basalt pebbles; neutral; abrupt wavy boundary.
IIC2-30 to 60 inches; dark grayish brown (10YR 4/2) extremely gravelly coarse sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; 60 percent pebbles and 5 percent cobbles; few very fine roots; neutral.

The mollic epipedon is 20 to 40 inches thick. The A horizon has value of 2 or 3 when moist, and it has chroma of 1 to 3 when moist or dry. The C horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 2 or 3. It is gravelly loam, gravelly very fine sandy loam, or gravelly silt loam. The IIC horizon is very gravelly sand, very gravelly loamy sand, or extremely gravelly coarse sand.

Zillah series

The Zillah series consists of very deep, somewhat poorly drained soils on flood plains adjacent to the Yakima River. These soils formed in recent alluvium. Slopes range from 0 to 2 percent. Elevation is 600 to 1,100 feet. The average annual precipitation is 6 to 9 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Typical pedon of Zillah silt loam, about 5 miles southwest of Sunnyside, about 300 feet north of the southeast corner of sec. 8, T. 9 N., R. 22 E.

A11-0 to 6 inches; grayish brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; common fine prominent mottles that are dark reddish brown (5YR 3/4) when moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots; common fine pores; moderately alkaline; abrupt smooth boundary.

A12-6 to 12 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; few fine prominent mottles that are dark reddish brown (5YR 3/4) when moist; weak fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; common fine pores; moderately alkaline; gradual wavy boundary.

C1-12 to 42 inches; gray (10YR 6/1) heavy silt loam, dark gray (10YR 4/1) moist; many large prominent mottles that are dark reddish brown (5YR 3/4) when moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; common fine pores; mildly alkaline; abrupt smooth boundary.

IIC2-42 to 60 inches; gray (10YR 5/1) loamy sand, very dark gray (10YR 3/1) moist; single grain; loose; few very fine roots; mildly alkaline.

Where these soils are not artificially drained, they are saturated with water at some period during the year. The profile is neutral to moderately alkaline.

The A horizon has value of 4 or 5 when dry and 2 or 3 when moist, and it has chroma of 1 or 2 when dry or moist. It is silt loam or sandy loam.

The C horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 1 or 2 when moist or dry. It is silt loam or very fine sandy loam and has strata of loamy sand below a depth of 40 inches. The IIC horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 1 or 2 when moist or dry. It is loamy sand, gravelly loamy sand, or very gravelly loamy sand.

formation of the soils

Soil is defined as a natural three-dimensional body on the earth's surface that supports plants. As a natural body, a soil has properties that differ from those of the underlying bedrock or unconsolidated material that is not soil. Properties of soils are a reflection of soil forming processes that are initiated and sustained by the effects of climate and living organisms acting on parent material and modified by topography over a period of time. In a given area, one factor may exert a stronger influence on soil formation than another, but the interaction of all the factors determines the kind of soil that forms.

In this survey, soil forming factors are discussed individually; however, the reader should be aware that there is a strong interdependence of all soil forming factors.

climate

Precipitation, by affecting the amount of water that enters the soil, influences the chemical and physical processes involved in the weathering of minerals, in erosion, and in leaching. Biological processes that determine the amount of residue returned to the soil and the rate at which the residue undergoes decomposition are dependent on moisture relationships in the soil forming environment. Temperature is a measure of the heat available for all physical, chemical, and biological processes involved in soil development. Heat, in the presence of adequate moisture, accelerates the weathering processes. Heat also increases evapotranspiration and thus reduces the amount of water available for chemical and geological processes.

Most of the precipitation in the survey area occurs in winter. The amount and seasonal distribution of the precipitation, together with soil temperature, have influenced the weathering of the parent material. The degree of weathering is reflected by the depth to which carbonates have been leached and by the amount of clay that has been translocated.

Soils in the 6- to 9-inch precipitation zone support grassland vegetation that is relatively low in productivity. Soils in this precipitation zone are partly recharged with moisture in winter. Because of low rainfall and high evapotranspiration, these soils are aridic but border on xeric. Organic matter content of the surface layer is relatively low. Some translocation of calcium carbonate from the solum and accumulation in the substratum are evident in Camborthids such as the Prosser, Scooteney, Shano, and Warden soils.

Soils in the 8- to 12-inch precipitation zone support grassland vegetation. The soil moisture regime in this part of the survey area is aridic, but it borders on xeric. The precipitation in this zone has promoted more plant growth and a higher content of organic matter in the surface layer of these soils than in those of the 6- to 9-inch precipitation zone. Carbonates generally are leached deeper in this part of the survey area than in the lower precipitation zone. The Cleman and Ritzville soils formed in the 8- to 12-inch precipitation zone. Some soils in this precipitation zone have been leached sufficiently of carbonates for clay illuviation to have occurred. The argillic horizon in these soils is not strongly expressed. The Cowiche, Renslow, and Simcoe soils are examples of these soils.

Soils in the 12- to 18-inch precipitation zone also support grassland vegetation. They have a xeric moisture regime. Carbonates have been leached from the profile of these soils. The mollic epipedon generally is darker colored than in soils that receive less precipitation. The agrillic horizon is more strongly developed and has a more pronounced structure. The McDaniel, Taneum, and Tieton soils are examples of these soils.

Soils in the 16- to 40-inch precipitation zone support conifers. They do not have carbonates in the soil profile. Base saturation is less than 75 percent in some part of the soils within a depth of 30 inches from the surface. This is a result of the low base cycling of most conifers and the leaching of bases. The Carmack, Meystre, Tekison, Odo, Sutkin, and Jumpe soils are examples of these soils.

In the extreme western part of the survey area, at elevations of 4,700 to 7,000 feet, precipitation is as high as 50 inches and cryic temperatures prevail. This cool, moist climate produces soils with an A horizon that is high in content of organic matter because of the slow rate of decomposition. These soils are strongly influenced by volcanic ash, do not have carbonates, and have less than 50 percent base saturation in the surface layer. Low base cycling, the leaching effects of high precipitation, and cold temperatures have influenced the development of the Naxing and Saydab soils.

parent material

Parent material is consolidated or unconsolidated mineral material. The formation of soils results from changes in the parent material. The nature of the changes involved is strongly influenced by the character of the parent material, particularly by its mineralogy and texture. Mineralogy and texture affect various physical and chemical aspects of the soil forming environment.

Parent material in the survey area includes recent alluvium; material derived from Yakima Basalt; loess; lacustrine sediment; material derived from siltstone, sandstone, and conglomerate of the Ellensburg Formation; volcanic ash; and eolian sand.

Most of the soils on terraces and uplands formed in loess. They are underlain by basalt, by a duripan, or by lacustrine sediment. The soils that formed in loess are dominantly silt loam. Soils of the Shano, Ritzville, and Renslow series are examples Of these soils.

Warden soils formed in a thin mantle of loess over stratified glaciolacustrine sediment known as the Touchet Formation. This late Pleistocene sediment is not well laminated. The Hezel soils formed in a mantle of eolian sand over glaciolacustrine sediment of the Touchet Formation.

Quincy soils formed in very deep eolian sand. These soils are dominantly loamy fine sand and are somewhat excessively drained.

Some of the soils in the survey area formed in loess over a lime- and silica-cemented duripan, and others formed over a silica-cemented duripan. The genesis of the duripan is not entirely understood. A commonly accepted theory is that the duripan is a relict feature associated with a previous soil forming cycle. It is thought to be an erosional remnant of an ancient soil. The upper material was eroded away during the late Pleistocene. The loess presently overlying the duripan is dominantly Holocene in age. The Willis, Burke, Scoon, and Moxee soils formed in a mantle of loess over a lime- and silica-cemented duripan. The Harwood, Gorst, and Gorskel soils formed in a thin mantle of loess over a silica-cemented duripan.

Some of the soils in the survey area formed in a mixture of loess and underlying sandstone of the Ellensburg Formation. The Cowiche, Taneum, and Meystre soils are examples of these soils. The Roza soils formed in fine textured material of the Ellensburg Formation. These soils have a high shrink-swell potential and are characterized by wide cracks in the surface that extend to a depth of 20 inches or more when the soils are dry. The Roza soils are Xerertic Camborthids.

Soils that formed in loess mixed with residuum and colluvium derived from basalt are those of the Bakeoven, Clint, Jumpe, McDaniel, Sapkin, and Sutkin series. The Loneridge and Tekison soils also formed in material derived from basalt and have accumulations of clay in the subsoil.

Soils that formed in material weathered from basalt with additions of volcanic ash and loess are those of the Naxing and Saydab series. Because of the properties of weathered volcanic ash, these soils have low bulk density. They are medial-skeletal Andic Cryumbrepts.

The most recent soil parent material is the Quaternary alluvium that is in stream valleys throughout the survey area. Soils of the Esquatzel, Kittitas, Fiander, Zillah, Umapine, and Outlook series formed in alluvium and have a silty control section. The Wenas, Toppenish, and Cleman soils are more influenced by sand or by sand and gravel, and they have a loamy ;control section. The Weirman and Mippon soils are sandy-skeletal and are near major drainageways. The Logy, Ashue, and Track soils are loamy-skeletal.

topography

Topography influences the soil forming processes by affecting runoff, drainage, and microclimate. In nearly level areas, runoff is very slow. Much of the water drains through the soil, and some evaporates. In sloping to steep areas, runoff generally increases with increasing slope. The more water that enters the soil, the greater the depth to which the soil is leached and weathered. The topography, through variations in exposure to the sun and wind and in air drainage, creates noticeable differences in vegetation and soil properties within short distances. For example, south-facing slopes receive more direct radiation from the sun than do the north-facing slopes. Consequently, south-facing slopes are warmer and drier.

Aspect has influenced the amount of loess that has accumulated. South and southwest aspects are exposed to the prevailing wind, and thus loess accumulation is less on these aspects than on north aspects. Also, because of the higher evapotranspiration rate on south and southwest aspects, plant density is less than on north aspects. With decreased plant density, the potential for water erosion becomes greater on south and southwest aspects. Representative soils that are on south and southwest aspects are the moderately deep Burke and Willis soils. Examples of soils on north aspects are the deep and very deep Ritzville and Shano soils. Water erosion in some areas has moved loess downslope. There has been little accumulation of loess on the edges of ridgetops and on narrow ridges. The Bakeoven, Bocker, and Rock Creek soils formed in residuum and colluvium derived from basalt in these areas.

Local relief modifies the moisture regime of soils. This is especially evident in soils on bottom lands. Possibly as a result of overirrigation, runoff from adjacent upland soils accumulates on bottom lands. A seasonal high water table is common in some of the soils on bottom lands. Mottling gives evidence of reducing regimes. Examples of soils that exhibit mottling and are somewhat

poorly drained are the Haplaquolls such as the Kittitas, Toppenish, Track, Wenas, and Zillah soils. These soils are along the Yakima, Naches, and Wenas Rivers. Some well drained soils on bottom lands are the Esquatzel, Clemen, Logy, and Yakima soils.

In some areas where the free water in the soil contains salts and is sufficiently close to the surface, evapotranspiration concentrates the salts in the surface layer. Included among these soils are the Fiander, Kittitas, Outlook, Sinloc, Umapine, and Wanser soils.

living organisms

The major biotic factor in soil development is vegetation. It is the principal source of the organic matter responsible for various chemical and physical properties of soils. Rodents, earthworms, and various other animals and insects assist in decomposing organic substances, and they mix the soil as a consequence of their burrowing activities.

The influence of vegetation is most evident in the A horizon. Plant species, productivity, and the rate at which residue decomposes strongly influence the properties of the A horizon. Dark colors in the A horizon generally indicate high organic matter content. Soils that receive about 6 to 16 inches of precipitation support grassland vegetation. Many of the soils that receive more than 16 inches of precipitation support coniferous forest. A relationship exists between the kind and amount of plant production and the color and thickness of the A horizon. Grass generally produces more organic matter in the A horizon than trees. Where plant production is high, the A horizon is thicker or darker colored than where production is low. The color and thickness of the A horizon of the Ritzville, Taneum, and Meystre soils reflect the influence of higher plant production than those of the Prosser, Shano, and Warden soils.

Soils on bottom lands contain the most organic matter relative to precipitation. One of the reasons is the relatively higher plant production stimulated by the accumulation of runoff from adjacent upland soils. Some soils formed under the influence of a seasonal high water table that reduces the rate of decomposition of organic matter. This is because of poor soils aeration, which reduces the activity of micro-organisms. The Wenas soil is an example of these soils.

Soils under forest vegetation are more leached of bases and other products of weathering than soils under grasses. One reason for the lower base saturation is the acidity of the leaching water under a coniferous forest canopy. Base saturation is less than 75 percent in the solum of the Carmack, Sutkin, and Tekison soils.

An ochric epipedon is common on the more densely forested soils. The Jumpe and Loneridge soils are examples of these soils. However, a thick, dark-colored A horizon is typical of soils in coniferous forests in the cryic temperature regime. One reason is the reduced biological activity of micro-organisms in cold temperatures, which results in reduced decomposition of organic matter. The Naxing and Saydab soils are examples of these soils.

time

Soil formation begins as soon as rock is exposed on the earth's surface. As soil formation progresses, characteristic layers called horizons form within the soil profile. Generally, the larger the number of horizons and the greater their thickness and distinctness, the more mature is the soil. Depending on the nature of the parent material and the vigor of the soil forming process, it takes hundreds or even thousands of years to form pronounced genetic horizons.

The parent material in the survey area is material derived from basalt and the Ellensburg Formation of Miocene age, stream terrace sand and gravel of Pleistocene and Pliocene age, volcanic ash of Pleistocene and Recent age, and Recent alluvium.

The soils in the area have been forming since Pliocene time. Some soils on basalt uplands have a strongly expressed argillic horizon. The Loneridge, Tekison, and Rock Creek soils are examples of these soils. A duripan formed in many of the soils on terraces during that time. Many of these soils since have been eroded to the duripan. Loess has been deposited in Pleistocene and Recent times over this old duripan, and a new soil is now forming in the loess. Stratigraphic studies in the Columbia Basin (25) indicate that the duripan is pre-Bull Lake in age (more than 50,000 years old). The Harwood, Gorst, and Gorskel soils are examples of these soils.

During the late Pleistocene (13,000 to 18,000 years ago) glacial water covered parts of the survey area. The parent material for the Warden, Scooteney, and Finley soils was deposited during this time.

Some of the younger soils in the area formed in recent alluvium on bottom lands, which are the youngest landforms in the area and are subject to flooding. These soils generally have an AC profile. The Esquatzel, Umapine, Weirman, and Yakima soils are examples of these soils.

Man's influence in the survey area has been considerable. Since the advent of irrigation, for example, overirrigation of soils in the higher lying areas has produced saline-alkali soils in the lower lying areas. The Outlook and Sinloc soils are examples of these soils. Through irrigation, land leveling, soil erosion, and alteration of native plant communities, man's presence will remain a highly significant soil forming factor in this survey area.

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glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as-

	Inches
Low	Less than 3.75
Moderate	3.75 to 5
Moderately high	5 to 7.5
High	More than 7.5

Basal area (forestry). The area of a cross section of a tree (including bark), usually expressed in square feet, and usually referring to the section at breast height. The basal area of a stand is the sum of the basal areas of individual trees and is computed per acre.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a winch with poles and pulleys to suspend and control the movement of wire cables. To reduce friction and soil disturbance, felled trees generally are yarded in with one end lifted or the entire log is suspended.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Chiseling. Loosening the soil, without inverting the soil material and with minimum of mixing of the surface soil, to shatter restrictive layers (in the upper 16 inches) that inhibit water movement and root development.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobble. A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Codominant trees. Well developed trees that are part of the main canopy but are subject to some competition from other trees.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose. -Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.-When dry, breaks into powder or individual grains under very slight pressure.
Cemented.-Hard; little affected by moistening.

Corrugations. Small channels used to carry water for surface irrigation of close-growing, noncultivated crops such as legumes, grasses, small grain, and mint. Water flowing through the corrugations soaks into the soil and spreads laterally, irrigating the areas between furrows.

Cover crop. A crop of close-growing grasses, legumes, or small grain grown to control seasonal erosion or for permanent cover in orchards and vineyards.

Culmination of the mean annual increment (CMAI). The average yearly volume growth of a stand of trees from the year of origin to the age that gives the highest average.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diameter at breast height. The diameter of a tree (including bark), usually expressed in inches, measured at a height of 4.5 feet above the average ground level.

Diversion. A channel that has a supporting ridge constructed across the slope on the lower side to divert excess water to sites where it can be used or disposed of safely.

Dominant trees. The largest, tallest, and most vigorous trees in a stand.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Drip irrigation. Very slow (about 1 gallon per hour), frequent applications of irrigation water. Water is applied through plastic emitters that normally are placed around the base of the plant commonly measured with a tensiometer. Drip irrigation helps to prevent the depletion of oxygen in the soil and allows optimum combinations of water and oxygen for plant growth.

Duff. A term used to identify a generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Duripan. A cemented layer. The layer normally is cemented by silica or calcium carbonate, or both.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Fallow (or summer fallow). Cropland left idle every other year in rotation with small grain. Weeds are controlled and moisture conserved during the idle year to retain adequate moisture for the cropping year. This 2-year rotation is common in regions of limited rainfall.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain.

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It is commonly on the downhill side of the road.

Firebreak. Areas cleared of flammable material to stop or help to control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of men and equipment in fire fighting. Designated roads also serve as firebreaks.

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover type. A descriptive term used to group stands of similar character as regards species composition and development because of ecological factors.

Furrow. Small channels used to carry water for surface irrigation of cultivated crops planted in rows. Water flowing in the furrows soaks into the soil and spreads laterally, irrigating the areas between furrows.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Grazable woodland. Forest land that produces, at least for a time, sufficient understory vegetation suitable for forage that can be grazed without significantly impairing the production of wood and other forest products.

Gully. A severely eroded site that has steep ditches cut by concentrated running water that ordinarily flows only after runoff. The distinction between a gully and a rill is one of depth and location. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage. A rill is less than 1 foot deep and generally can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.-An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.-The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).-Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Meadow farmed (mint). A cultural practice that consists of using tillage only during establishment of the mint crop. In some instances, the original corrugations are reestablished if water does not stay in the corrugations or flow to the end of the field.

Mean annual increment. The average yearly volume growth of a stand of trees from the year of origin to the age under consideration.

Minimum tillage. Properly timed noninversion conservation tillage that is limited to only those operations essential to crop production and prevention of soil damage. The purpose of minimum tillage is to avoid deterioration of soil structure; to reduce soil compaction and formation of a tillage pan; to improve soil aeration, permeability, tilth; and to maintain residue on the surface.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, *common,* and *many,* size-fine, *medium,* and *coarse;* and contrast-faint, *distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables-hue, value, and chroma. For example, a notation of 1 OYR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Natural reforestation. Seedlings that become established from seed disseminated by nearby cone bearing trees. The expected period of time it takes for an area to naturally reforest is described by the terms *readily,* seedlings adequately occupy the area in 2 to 5 years; *periodically,* 5 to 10 years; and *infrequently,* 10 to 20 years.

Normal stand (woodland). A normal stand, at a given age, contains as many trees per acre as can properly use the growing space available. It is considered to be fully stocked.

Nurse crop. A companion crop grown to protect some other crop sown with it.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Planned grazing system. A system in which two or more grazing units are alternately rested from grazing in a planned sequence over a period of years. The rest period can be throughout the year during the growing season of the key plants.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Reforestation. Tree seedlings that are planted or are naturally established in an area of land that was once forested. It includes the practices associated with planting.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. An obvious erosion pattern resulting from rainfall or runoff from snowmelt. Usually referred to as sheet and rill erosion. See `gully` for more detail.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site curve (50-year). A set of related curves on a graph that shows the average height of dominant trees for a range of ages on soils that differ in productivity. Each level is represented by a curve.

Site curve (100-year). A set of related curves on a graph that shows the average height of dominant and codominant trees for a range of ages on soils that differ in productivity. Each level is represented by a curve.

Site index. The height that dominant or dominant and codominant trees reach at 50 years total age, of breast height age, of 100 years total age, or at breast height age. With this index and the age of the stand of trees, yield can be determined by using the appropriate yield table.

Skid trail. The path left by skidded logs and by the equipment used to pull them.

Skidding. A method of moving felled trees to a nearby, central area for transport to a processing facility. Most skidding systems involve pulling the trees with wire cables attached to a bulldozer or rubber-tired tractor. To reduce friction and soil disturbance, felled trees generally are pulled with one end lifted.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope gradient. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope length. The distance from the origin of the overland flow to the point where the slope gradient decreases enough that deposition begins or the runoff water enters a well-defined channel.

Stocking (woodland). The degree to which an area is effectively covered with living trees. It is expressed as a percentage of the basal area or crown closure relative to that of a normal stand. *Well stocked* is 70 to 100 percent of a normal stand; *medium stocked* is 40 to 70 percent; *poorly stocked* is 10 to 40 percent; *nonstocked* is less than 10 percent; and *overstocked is* more than 100 percent.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands to reduce erosion. The crops are arranged so that a protective strip of

grass or a close-growing crop is alternated with a strip of a clean-tilled crop or fallow. Contour strips follow the contour of the slope and are designed to reduce sheet and rill erosion and control water. Field strips are placed across the slope to reduce sheet and rill erosion. Wind strips are arranged at angles generally perpendicular to erosive winds to control soil blowing, trap snow, and increase the soil moisture content.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless soils* are either *single grained* (each grain by itself, as in dune sand) or *massive* (±he particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Residue of small grain left on the surface of the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Loosening the soil without inverting it and with a minimum of mixing of the surface layer to shatter restrictive layers (at a depth of more than 16 inches) that inhibit water movement or root development.

Substratum. The part of the soil below the solum.

Suitable surfacing (logging roads). Rock of adequate hardness and size used to cover a road so that it can withstand repeated and long-term logging truck traffic.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An earth embankment, channel or ridge and channel constructed across the slope (gradient terrace) or on the contour (level terrace) to (1) reduce slope length, (2) reduce erosion, (3) reduce the content of sediment in runoff water, (4) intercept and conduct surface runoff to a stable outlet, (5) retain runoff for moisture conservation, (6) prevent development of gullies, (7) reform the land surface, (8) improve the soil for farming, and (9) reduce flooding.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than bottom land or terraces.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Water bar. A smooth, shallow ditch or depressional area that is excavated at an angle across a sloping road. It is used to reduce the downward velocity of water and to divert the water off and away from the road surface. Water bars can easily be driven over is constructed properly.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The action of uprooting and tipping over trees by the wind.

Yarding path. The path left by cable-yarded logs as they are pulled uphill or downhill to a nearby, central area.

Yield table, normal (woodland). Table showing the number and size of trees, total basal area, and yield per acre. These tables commonly are for even-aged, unmanaged stands. Values are given for stands at different ages on sites of different quality.

Yield (woodland). The volume of wood fiber from trees harvested from a certain area. Yield commonly is measured in board feet or cubic feet per acre.