SOIL SURVEY

Baker Area Oregon

Series 1941, No. 9

Issued January 1954

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with the
OREGON AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have worked with their soils for a long time know about the soil differences on their own farms, and perhaps about differences among soils on farms of their immediate neighbors. What they do not know, unless soil surveys have been made, is how nearly their soils are like those on experiment stations or on other farms, either in their State or other States, where farmers have gained experience with new or different farming practices or enterprises. The farmers of the Baker area can avoid some of the risk and uncertainty involved in trying new crop and soil management practices by using this soil survey report, for it maps and describes the soils in their vicinity and allows them to compare the soils on their farm with soils on which new developments have proved successful.

SOILS OF A PARTICULAR FARM

The soils of the Baker area are shown on the map placed in the envelope inside the back cover of this report. To learn what soils are on a farm (or other tract of land) it is first necessary to locate it on the map. Find the general location of the farm by using township and section lines, and then locate its boundaries by reference to roads, streams, villages, dwellings, and other landmarks. Remember that an inch on the map equals a mile on the ground.

The next step is to identify the soils on the farm. Suppose, for example, one finds an area marked with the symbol Gu. Look among the rectangles in the margin of the map and find the one with Gu printed on it. Just above the rectangle is the name of the soil—Gooch silty clay loam.

What is Gooch silty clay loam like, for what is it used, and to what uses is it suited? This information will be found in the section on Soil Descriptions. How productive is this soil? The answer will be found in table 5. Find in the left-hand column of this table the name Gooch silty clay loam and read in the columns opposite the yields of different crops this soil can be expected to produce with or without irrigation. Compare these yields with those given in the table for other soils of the area.

What uses and management practices are recommended for Gooch silty clay loam? Most of this information is given in the section on Soil Descriptions, but refer also to the section on Soluble Salts and Alkali in Soils and the section on Irrigation and Water Supply.

SOILS OF THE COUNTY AS A WHOLE

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

A newcomer to the county, especially if he considers purchasing a farm, will want to know about the climate; the types and sizes of farms; the principal farm products and how they are marketed; the kind and conditions of farm tenure, including tenancy; kinds of farm buildings, equipment, and machinery; churches, schools, roads, and railroads; the availability of telephone and electric services and water supplies; the industries of the county; and cities, villages, and population characteristics. Information about all these will be found in the section on General Nature of the Area and in the section on Agriculture.

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

This publication on the soil survey of the Baker area, Oreg., is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

and the

OREGON AGRICULTURAL EXPERIMENT STATION

Series 1941, No. 9 Issued January 1954

SOIL SURVEY OF THE BAKER AREA, OREGON

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United States Department of Agriculture in cooperation with the Oregon Agricultural Experiment Station

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[1] The Division of Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

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MOST of the Baker area lies in Baker County, one of the leading livestock-producing counties in Oregon. The remaining part, about 50 square miles, is in Union County. Nearly all of the farm land lies in the valleys; for the most part, the surrounding forests and semiarid range lands are unsettled and are used for grazing sheep and cattle. Farming began in the area nearly a century ago, shortly after gold was discovered, and has since outstripped mining and logging, the other important industries. Hay and grains, the principal crops, are fed mainly to livestock on the farms, but some wheat is marketed. Crops are raised almost entirely under irrigation, and there is a considerable acreage of irrigated pasture. Mining is still a leading industry in Sumpter Valley, and there are two large sawmills at Baker, but most of the people gain their livelihood by farming. To provide a basis for the best agricultural uses of the land, this cooperative soil survey was made by the United States Department of Agriculture and the Oregon Agricultural Experiment Station. The survey was completed in 1941, and unless otherwise specifically mentioned, all statements pertain to conditions at the time of survey.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Baker County lies on the eastern border of Oregon a little north of the center of the State (fig. 1). Baker, the county seat, is 240 miles southeast of Portland.

The Baker area is made up of five large valleys separated by range lands in the northern part of Baker County, and a small area in the southern part of Union County. The valleys are Baker (or Powder), Sumpter, Pine, Eagle, and Lower Powder. The valleys cover 572 square miles; the intervening range and forest lands, 248 square miles.

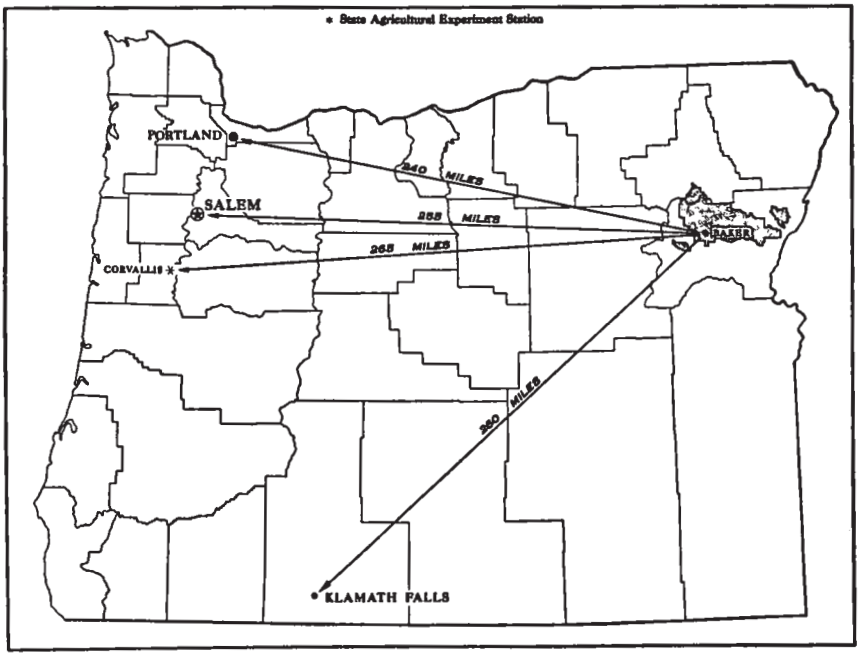

FIGURE 1.—Location of the Baker area in Oregon.

The total area surveyed is approximately 820 square miles, or 524,800 acres. The valley lands are surveyed in more detail than the intervening areas.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The Baker area is in the Payette and Blue Mountain sections of the Columbia Plateau province and lies between the Blue and Wallowa Mountains. This area is mainly hilly and rocky, but the floors of the valleys are fairly smooth because they have deep coverings of stream or lake deposits. Except in Baker Valley where considerable areas are influenced by a high water table, drainage is fairly adequate. All the valleys in the Baker area except Pine Valley are drained by the Powder River or its tributaries. Pine Valley is drained by Pine Creek, which flows eastward into the Snake River.

The main physiographic divisions of Baker Valley and the adjoining area are (1) nearly flat broad alluvial plains or old lake bottoms with fingers following up the larger streams, (2) sloping alluvial fans leading westward toward the mountains, (3) older gently sloping alluvial terraces, and (4) hilly to mountainous areas underlain by bedrock (*1*, *6*, *7*).[1a]

Bordering Baker Valley on the west is Elkhorn Ridge, a division of the Blue Mountains. West of the south end of Baker Valley the rocks are mostly argillite and other metamorphics but some are basalt and other lava rock. West of the north end of the valley the rocks are mostly biotite-quartz diorite and some lava. Here the relief is steep and mountainous. Dooley Mountain, south of Baker Valley, has steep broken relief. It is made up largely of volcanic rock, such as rhyolites and breccias. Materials from these rocks have been carried down by streams and have contributed to the soil material in the valley. On the east, Baker Valley is bordered by hilly areas of moderate relief, which are underlain by weakly consolidated stratified deposits of lava, granite, argillite, greenstone, and other rock materials.

Sumpter Valley is about 20 miles southwest of the town of Baker. The valley floor is nearly flat and is underlain by recent sediments having a gold-bearing gravelly substratum. This valley is partly bordered on the north and south by old high gravelly terraces and alluvial fans that merge into mountain foothills. Argillite and other metamorphic rock formations predominate to the north, lava to the south and east, and granite and argillite to the west.

Pine Valley is a basinlike area 65 miles northeast of Baker by highway. It consists of a smooth gently sloping valley floor, low terraces, and shallow depressions. The soil materials consist of alluvial wash from the bordering mountains. The alluvium on the valley floor is largely from granitic materials because Pine Creek traverses granitic areas in the Wallowa Mountains. Basalt, greenstone, limestone, and other rocks, however, are mixed with the granitic material. The valley floor is underlain by a gravelly or cobbly substratum consisting of a mixture of water-worn granite, basalt, greenstone, argillite, quartzite, and other rocks (*2*, *9*).

The floor of Pine Valley passes abruptly into the foothills to the west and into lava benches to the east. The rock along the valley border is predominantly basalt. Basalt underlies a benchlike area south of Pine Valley, as well as Posey Valley, an extension of Pine Valley to the south.

Eagle Valley, 40 miles east of Baker by highway, is at the confluence of Eagle Creek and the Powder River. It consists of nearly level bottom lands along streams and is bordered by a series of terraces and alluvial fans that merge into the low bordering mountains. The bottoms lands are underlain by gravelly deposits having thin coverings of loamy material. The gravel and associated cobblestones are a mixture of basalt, granite, greenstone, and other metamorphic and lava rocks carried down by Eagle Creek from the Wallowa Mountains to the north. The large terrace on which Richland is located is 50 to 100 feet above the Powder River. Here the soil is underlain by gravel and water-worn cobblestones similar to the material along Eagle Creek, but the gravel and cobblestones are weakly consolidated.

[1a] Italic numbers in parentheses refer to Literature Cited, p. 172.

West of Eagle Creek is a series of benches reaching a maximum elevation of about 400 feet above the Powder River. They consist largely of layers of weakly consolidated gravel, clay, diatomite, tuff, tuffaceous sandstone, and other materials that rest on basalt. The highest benches are underlain by lava. Gulches have eroded into the benches but their sides are gently sloping. The higher benches merge on their lower side with sloping alluvial fans and old lava flows that surround the valley floor.

Lower Powder Valley, often called Keating Valley, is about 20 miles northeast of Baker. It is a basinlike area between two canyons and is traversed by the Powder River, which at this point flows southeastward. The floor of Lower Powder Valley is nearly level and rather poorly drained. The soils have developed from a rather deep layer of fine materials. The substratum is coarse alluvium derived from a variety of rocks, including greenstone, basalt, granite, argillite, and other metamorphic materials. Low benches border the first bottom and break sharply into the surrounding uplands. Fairly well-drained stream bottom lands extend up the creeks to the north of Lower Powder Valley. To the south the streams are mostly in narrow V-shaped valleys with very narrow bottoms.

The uplands bordering Lower Powder Valley are composed of old stream and lake materials, which in places are weakly consolidated. The relief is that of high dissected benches and fans with small flat-topped areas intervening. About 5 miles to the south, Lower Powder Valley merges into a semimountainous ridge underlain by argillite and other rocks. About 2 miles to the north is a belt of greenstone that continues to the border of the Wallowa Mountains. To the northwest and west are large areas of deeply dissected sloping lava benches; to the northeast extensive areas are underlain by albite granite. These areas, as well as the headwaters of the Powder River in the Blue Mountains, have contributed most of the soil material in Lower Powder Valley.

Baker, the county seat, has an altitude of about 3,446 feet.[2] Altitudes at other points in the area surveyed are: Haines, 3,329 feet; North Powder, in the lower part of Baker Valley, 3,242 feet; the western border of Baker Valley, about 4,000 feet; Sumpter, at the upper end of Sumpter Valley, 4,415 feet. Hunt Mountain, 8,232 feet, is the highest point in the area.

CLIMATE

The Baker area has an invigorating continental climate with a high percentage of sunshine. Summers are warm and dry; winters are cold and have moderate snowfall. The frost-free period, or growing season, is relatively short, but the climate is especially favorable for the production of livestock and the growing of hay crops under irrigation. The more important climatic data for the area are given in table 1.

[2] Altitudes determined by the U. S. Geological Survey in connection with topographic surveys.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at indicated weather stations in Baker County, Oreg.*

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
BAKER, ELEVATION 3,446 FEET							
December	27.3	59	−24	1.70	1.16	4.00	10.5
January	24.9	55	−22	1.39	.34	2.04	11.0
February	29.0	59	−20	1.23	1.25	2.59	7.0
Winter	27.1	59	−24	4.32	2.75	8.63	28.5
March	37.6	74	−12	1.10	.37	1.40	5.6
April	45.2	83	15	1.09	.54	.37	1.6
May	51.7	90	21	1.55	.29	1.37	.2
Spring	44.8	90	−12	3.74	1.20	3.14	7.4
June	58.6	98	27	1.34	.37	2.59	[1]
July	65.6	102	34	.58	.04	1.83	0
August	64.6	101	31	.49	.39	.43	0
Summer	62.9	102	27	2.41	.80	4.85	[1]
September	56.0	94	16	.74	.17	.14	[1]
October	46.6	85	12	.91	.32	.16	.4
November	36.0	66	−8	1.05	1.15	1.31	3.5
Fall	46.2	94	−8	2.70	1.64	1.61	3.9
Year	45.3	102	−24	13.17	[2] 6.39	[3] 18.23	39.8
RICHLAND, ELEVATION 2,315 FEET							
December	30.3	65	−22	1.28	0.78	0.92	7.4
January	27.9	60	−22	1.15	1.10	1.72	8.6
February	33.9	65	−11	1.05	[1]	1.42	7.7
Winter	30.7	65	−22	3.48	1.88	4.06	23.7
March	41.2	78	−9	.77	.85	.38	1.8
April	48.9	90	13	.74	.71	1.18	.7
May	55.7	99	22	1.16	.87	2.61	[1]
Spring	48.6	99	−9	2.67	2.43	4.17	2.5
June	63.7	105	19	.67	.49	1.20	0
July	71.2	110	33	.28	0	.13	0
August	70.0	108	31	.34	.21	.39	0
Summer	68.3	110	19	1.29	.70	1.72	0
September	59.6	103	18	.54	1.10	.30	0
October	49.4	93	14	.72	.90	.93	[1]
November	39.5	76	−7	1.11	.33	3.03	2.6
Fall	49.5	103	−7	2.37	2.33	4.26	2.6
Year	49.3	110	−22	9.81	[4] 7.34	[5] 14.21	28.8

See footnotes at end of table.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at indicated weather station in Baker County, Oreg.*—Continued

SPARTA, ELEVATION 4,150 FEET

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
December	26.8	62	−22	3.40	0.56	3.95	30.8
January	24.6	65	−14	3.13	2.53	5.17	30.6
February	27.8	68	−16	2.34	1.31	3.80	23.0
Winter	26.4	68	−22	8.87	4.40	12.92	84.4
March	34.9	74	−5	1.88	.17	3.10	14.6
April	43.5	81	13	1.24	1.13	2.20	4.5
May	50.9	87	20	1.74	2.42	2.70	.3
Spring	43.1	87	−5	4.86	3.72	8.00	19.4
June	58.2	94	21	1.26	.47	1.80	.2
July	67.4	106	31	.60	.05	.17	0
August	67.4	105	31	.61	.20	2.58	0
Summer	64.3	106	21	2.47	.72	4.55	.2
September	57.4	95	22	.95	.67	[1]	[1]
October	47.4	88	14	1.30	1.36	3.00	2.2
November	36.2	75	−12	2.52	3.01	5.30	17.1
Fall	47.0	95	−12	4.77	5.04	8.30	19.3
Year	45.2	106	−22	20.97	[5] 13.88	[6] 33.77	123.3

[1] Trace.
[2] In 1924.
[3] In 1891.
[4] In 1908.
[5] In 1921.
[6] In 1889.

The climate of the Baker area varies with altitude and relief. In general the greater the altitude, the greater the precipitation and the lower the average temperature. Baker Valley has a semiarid climate. The average annual precipitation is less than 14 inches. This broad level valley is virtually a high meadowlike mountain basin surrounded by higher lands. The nearby mountains to the west remain snow-covered until late spring or early summer and are the source of much cold air that settles in lower areas. Cold winds from these snow-capped peaks are common through April and May. Pockets of cold air cause late spring frosts in central Baker Valley, but air drainage on the slopes and in the valley near the mouths of canyons is good.

Sparta (alt. 4,150 feet) has a fairly moist subhumid climate and an average annual precipitation of 20.97 inches. The average annual precipitation at Richland (alt. 2,315 feet) is 9.81 inches. The soils and vegetation in Sumpter Valley indicate a subhumid climate. The high mountainous areas are humid and receive heavy snowfall.

Except where a high water table subirrigates the soil, the annual precipitation is usually not sufficient for maximum crop production. Irrigation is necessary. Significant quantities of rain rarely fall in July or August. Thunderstorms are common, but most of the mois-

ture falls as gentle rain or snow. Hailstorms occur at long intervals. Warm rains that melt the snow quickly or cloudbursts in the mountains sometimes cause floods in the valleys. At higher elevations and in Pine Valley snow covers the ground most of the winter, but in the lower valleys snows remain on the ground for only short periods. Generally, work in the fields may be started in March.

As indicated in table 1, there is a spread of about 36 degrees between mean winter and summer temperatures at Baker. In summer the temperature may stay around 100° F. for several days in succession. The extreme range in temperature at Baker is 126°. The highest temperature recorded at that station is 102°; the lowest, −24°. Richland, in the eastern part of the county and 1,131 feet lower than Baker, has an average winter temperature 3.6° higher and an average summer temperature 5.4° higher than Baker. The highest recorded temperature at Richland is 110°; the lowest is −22°.

The frost-free season varies according to altitude and air drainage. The dates of killing frost and the average length of the frost-free season at the weather stations listed in table 1 are as follows:

	Weather Station		
	Baker	*Richland*	*Sparta*
Average date of last killing frost in spring	May 14	May 21	May 8
Average date of first killing frost in fall	Sept. 30	Sept. 28	Oct. 14
Latest recorded date of killing frost in spring	June 23	June 24	June 19
Earliest recorded date of killing frost in fall	Aug. 30	Aug. 30	Sept. 11
Average length of frost-free season in days	139	130	159

The actual growing season is somewhat longer than the frost-free period because hay and grain, the principal crops, are somewhat resistant to frost. Also, areas with exceptionally good air drainage have a longer frost-free period. The grazing season commonly begins in April and continues into December, but there is some browsing by stock all winter. Spring comes much earlier at Richland than at Baker.

Prevailing winds are from the northwest in summer and from the southeast the rest of the year. The wind velocity usually ranges from 6½ to 7½ miles an hour. Wind velocities are highest in December, January, and February and in those months may reach 40 miles an hour. The rest of the year the highest wind velocities are between 30 and 35 miles an hour. High winds are rare, and tornadolike storms are unknown in the area.

Sunshine is abundant. During July and August the sun shines more than 80 percent of the total time possible, and throughout the rest of the year it shines nearly 56 percent of the possible total. Midsummer days are warm but not oppressive, because the humidity is low.

VEGETATION

Big sagebrush and grass are the vegetation most common on well-drained land in the Baker area. The grasses, mostly short bunchgrasses growing in small tufts, produce a good sod where conditions are favorable and where the land has not been overgrazed.

Some of the most common grasses on well-drained land are downy chess, locally known as cheatgrass; Sandberg bluegrass, also known as sheepgrass and little bluegrass; Nevada bluegrass; bluebunch wheatgrass; Idaho fescue, or blue bunchgrass; and Indian ricegrass. According to early settlers sagebrush was not so prevalent when the

area was first settled, but it now overshadows the grass in nearly all areas. Sagebrush provides poor browse for stock when grass is scarce. Bitterbrush is common in Pine Valley and provides a good browse for stock. Kentucky bluegrass is abundant in irrigated areas. Meadow fescue, crested wheatgrass, and orchard grass are important in pastures. Pinegrass is common in Pine Valley.

Saltgrass and greasewood thrive on saline and alkali soils. Much foxtail, or wild barley, and some alkali grass, bluejoint, and other grasses grow on saline soils. Rabbitbrush, mullein, and thistles are common on slightly saline soils but also thrive on well-drained ones. Tall ryegrass, or giant wild-rye, grows along irrigation ditches; cattails, sedges, and tules grow in marshy areas (*3*).

Sagebrush and grass is prevalent up to elevations of about 4,000 feet, where a scattered growth of ponderosa pine, juniper, and mountain-mahogany begins. Ponderosa pine is generally the predominant species in a belt above an altitude of 4,500 feet, but at higher altitudes the pine merges with Douglas-fir, western larch, and white fir. Lodgepole pine, Englemann spruce, and alpine fir grow at still higher altitudes. Cottonwood, aspen, alder, and hoghaw grow on moist land. Chokecherry, wild rose, oceanspray, snowberry, ninebark bush, raspberry, spirea, nettles, fern, and other shrubs and trees occur as underbrush and in open spaces in timbered areas.

The common flora[3] of the Baker area are listed alphabetically by scientific name as follows:

Scientific name	*Common name*
Abies concolor	White fir
A. lasiocarpa	Alpine fir
Achillea lanulosa	Yarrow, or western yarrow
Agoseris sp	Mountain-dandelion
Agropyron cristatum	Crested wheatgrass
A. spicatum	Bluebunch wheatgrass, or big bunchgrass
Alnus sp	Alder
Amelanchier alnifolia	Common serviceberry
Artemisia tridentata	Big sagebrush
Astralagus sp	Locoweed
Balsamorhiza sp	Balsamroot
Bromus tectorum	Downy chess, or cheatgrass
Calamagrostis canadensis	Bluejoint
Castilleja linariaefolia	Wyoming paintbrush
Ceanothus velutinus	Ceanothus, or snowbrush
Cercocarpus ledifolius	Curlleaf mountain-mahogany
Chrysothamnus sp	Rabbitbrush
Crataegus douglasii	Black hawthorn, hoghorn, or hoghaw
Dactylis glomerata	Orchard grass
Delphinium sp	Larkspur
Distichlis stricta	Desert saltgrass, or saltgrass
Elymus condensatus	Giant wild-rye, or tall rye-grass
Eriogonum sp	Wild buckwheat, or buckwheatbrush
Festuca idahoensis	Idaho fescue, or bluebunch fescue
F. octoflora	Annual fescue, or sixweeks fescue
Holodiscus discolor	Oceanspray
Hordeum jubatum	Foxtail barley, foxtail, or wild barley
H. pusillum	Little barley, or wild barley
Juncus sp	Rush
Juniperus occidentalis	Juniper
Larix occidentalis	Western larch, or tamarack
Lupinus sp	Lupine

[3] Identified by Kenneth J. Crawford, range examiner, Production and Marketing Administration, U. S. Department of Agriculture.

Oryzopsis hymenoides	Indian ricegrass
Phlox sp	Phlox
Physocarpus sp	Ninebark bush
Picea engelmanni	Engelmann spruce
Pinus contorta	Lodgepole pine
P. ponderosa	Western yellow pine, or ponderosa pine
Poa nevadensis	Nevada bluegrass
P. pratensis	Kentucky bluegrass
P. secunda	Sandberg bluegrass, or sheepgrass
Populus tremuloides	Quaking aspen
P. trichocarpa	Black cottonwood
Potentilla sp	Cinquefoil
Prunus demissa	Western chokecherry
P. emarginata	Bitter cherry
Pseudotsuga taxifolia	Douglas-fir
Pteridium aquilinum	Bracken
Puccinellia lemmoni	Alkali-grass
Purshia tridentata	Bitterbrush, or antelope brush
Rosa sp	Wild rose
Rubus sp	Raspberry
Salix sp	Willow
Salsola kali var. *tenuifolia*	Tumbling russianthistle
Scirpus sp	Rush
Sisymbrium altissimum	Jim Hill mustard, or tumbling mustard
Sitanion hystrix	Squirreltail
Spiraea sp	Spirea
Stipa comata	Needle-and-thread grass
Thlaspi alpestre	Pennycress
Typha latifolia	Common cattail
Urtica sp	Nettles
Verbascum thapsus	Common mullein
Zigadenus sp	Deathcamas

WILDLIFE

Wildlife is rather scarce in the Baker area because it is largely open country. The higher timbered parts of Baker County, not included in the area surveyed, abound in deer, elk, and bear and are favorite hunting grounds for Oregon and neighboring States. Chinese pheasants are fairly common in settled parts of the Baker area, and there is some duck and goose shooting in season. Placer mining along the upper reaches of the Powder River has not been conducive to fish life, but good fishing is reported for smaller streams in the adjacent forests.

ORGANIZATION AND POPULATION

Between 1842 and 1847 many immigrants on their way to the Willamette Valley followed the old Oregon Trail across the Baker area. The first settlement in the area, a mining camp at Sumpter, was made in the early 1850's by miners seeking gold in the Blue Mountains. Prospecting in that area began after the first gold excitement in California had partly subsided. The discovery of gold at Griffins Gulch, west of Baker, in 1861 brought a great influx of settlers the following year. A large settlement was made at Auburn, and by this time an extensive camp had been established at Sumpter and smaller settlements had been made near other placer mines.

Baker County was organized in 1862, and 2 years later Union County was formed from its northern part. In 1887 Malheur County was formed from the southern part of Baker County. Farming began in 1863 to supply produce for the miners, but most other supplies were

hauled in over the Blue Mountains from Umatilla, a settlement on the Columbia River. Hauling continued until 1883, when rail traffic was opened by the Oregon-Washington Railroad & Navigation Co., now a part of the Union Pacific system.

The population of Baker County was 16,175 in 1950. The present inhabitants are largely descendants of the early settlers, who came mostly from States in the Middle West.

Baker—population 9,471 in 1950—is the county seat and lies at the south end of Baker Valley. Other population centers are Sumpter, in the valley of the same name; Haines, in the central part of Baker Valley; North Powder, in the northern part of Baker Valley; Keating, in a basinlike area in the Lower Powder Valley; Richland and New Bridge, in Eagle Valley; and Halfway, Langrell, Pine, and Carson in Pine Valley. Several other towns in Baker County are outside the area surveyed. Robinette, on the Snake River, is one of these.

INDUSTRIES

Agriculture is the leading source of livelihood in the Baker area. In 1940, 1,968 people were employed in agriculture; 572 in mining and quarrying, chiefly placer mining; 126 in logging; and 382 in lumber mills.

Processing of farm produce provides some employment. Surplus dairy products, principally butter and cream, are processed in creameries at Halfway and Richland and in two plants in Baker. Flour and other cereal products are milled at Baker and Halfway.

Baker is the center for one of the important gold-mining areas of the United States and has machine shops and foundries for making parts and repairs for mining machinery and other equipment. Over $150,000,000 in gold has been mined since gold was discovered in 1861. Most of the gold came from placer mines, but a considerable quantity has been taken from lode mines.

Some silver and copper have been obtained in the area. A little lignite coal of poor quality has been mined, and antimony was mined near Baker during the first World War. Deposits of diatomite (diatomaceous earth) are common, and deposits of asbestos, tungsten, and manganese ores have been reported. Much granite for monuments and building has been quarried near Haines, and a small quantity of limestone has been quarried west of Baker. Many buildings in Baker are constructed of volcanic tuff obtained east and south of the city.

A large part of the lumber produced in the area is manufactured at Baker, where two large mills are located. The logs are brought into Baker by train from hills surrounding Sumpter Valley. The annual cut ranges from 30 to 50 million board feet, more than 95 percent of which is ponderosa pine. The rest is Douglas-fir and western larch. The lumber mills have a capacity of about 275 thousand board feet each 8-hour shift.[4] Box shook, molding, lath, sash and doors, and other special lumber products are manufactured at Baker in small quantity.

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[4] BOLLES, W. H., WOLFE, H. M., and SMITH, C. S. FOREST STATISTICS FOR BAKER COUNTY, OREGON. Pacific Northwest Forest Expt. Sta., Forest Survey Rpt. 44, 15 pp., illus. 1937. [Processed.]

TRANSPORTATION AND MARKETS

A main line of the Union Pacific Railway crosses Baker Valley and provides through transportation to the east and west. A branch line extends down the Snake River to Robinette and is an important means of shipping livestock from Pine and Eagle Valleys. The narrow-gauge railroad along the Powder River, used principally as a logging road, connects Baker with the Sumpter Valley area. The hard-surfaced United States Highway No. 30, following the route of the old Oregon Trail, parallels the main line of the Union Pacific Railway and provides excellent southeast-northwest transportation by bus and truck.

A good public road, hard-surfaced in part, leading 65 miles east from Baker to Halfway is used for carrying passengers and freight but not for marketing livestock. The long haul from valleys along this road discourages wholesale trucking of agricultural products. A good highway leading south from Baker and then west to Sumpter Valley is used for transporting local freight to and from the southern part of the area. Good market roads have been built to most of the farms in the irrigated valleys, but few roads exist in the grazing areas between the valleys or in the mountainous parts of the county.

The city of Baker, lying in the largest agrictultural area in the county, is an important local market for farm products. Other markets for agricultural communities are Sumpter, Haines, North Powder, Keating, Richland, Newbridge, Halfway, Langrell, Pine, Carson, and Robinette. The last named is outside the area surveyed.

CULTURAL DEVELOPMENTS AND IMPROVEMENTS

Churches are located in larger communities, and public schools are of a high order. High schools are available to all pupils, and free transportation is provided in all except the densely populated areas. Baker is a thriving city offering all the modern conveniences.

Farm dwellings are commodious and well built, but outbuildings are generally not substantial. Many of the barns and other farm buildings are below the standard for farm communities in the Northern States. Most fences are adequate. According to census reports, there were 1,052 farms in Baker County in 1950, and in that year 862 farms reported electricity, and 540 farms, telephones.

The farming sections of the county are well supplied with trucks and tractors, and there are a number of combines. There were 812 motortrucks on 666 farms in 1950, 862 tractors on 582 farms, and 822 automobiles on 650 farms.

AGRICULTURE

Agriculture began in Sumpter Valley in 1863, or shortly after the discovery of gold in the Blue Mountains, and from there spread to Baker and other valleys. In early years farming was done in an intermittent way because gold mining was of first interest. Many divided their time between mining and farming. At first, agriculture centered around the grazing of livestock, but potatoes, vegetables, grains, and hardy fruits were soon planted to meet the growing demand for farm produce in the mining camps.

Agricultural development (*4*) was gradual for the first 20 years after settlement began. The range was stocked with cattle and sheep, irrigation ditches were dug, and the more accessible land was brought under cultivation. Much native grass was cut for hay. Many cattle and horses were driven from the area to replace Texas longhorns on the Montana and Wyoming range. Many finished beef cattle were driven to Winnemucca, Nev., for shipment to Omaha, Nebr., and a few were driven to Portland. Crops and farm produce were grown mostly for local consumption because adequate transportation to outside markets was lacking.

After construction of the railroad in 1883, agricultural development was fairly rapid. Farming now leads all other enterprises. Practically all farming is on the lowlands, terraces, and fans of the five major valleys. A few small areas on the uplands in the vicinity of Sparta are dry-farmed, but for the most part the dry lands intervening between the valleys are used for grazing. Many cattle and sheep are grazed in the National forests during summer, but they are fed on the farms during winter. Surplus wheat grown in the area is shipped to outside markets, but other grains are nearly all used locally.

CROPS

The acreages of principal crops grown in Baker County in stated years are listed in table 2. The area surveyed does not have the same boundaries as Baker County, but the figures in table 2 are representative because most of the land surveyed is in the major valleys in the northern part of the county, or that part best suited to agriculture.

TABLE 2.—*Acreage of principal crops and number of bearing fruit trees in Baker County, Oreg., in stated years*

Crops	1919	1929	1939	1949
	Acres	*Acres*	*Acres*	*Acres*
Small grains threshed:				
Wheat	19, 885	17, 445	10, 097	21, 837
Barley	4, 036	5, 324	6, 752	11, 653
Oats	6, 439	6, 558	4, 208	1, 581
Rye	1, 290	996	1, 217	267
Corn, all purposes	365	350	561	225
All hay	130, 136	78, 684	69, 818	65, 930
Alfalfa	33, 488	36, 231	32, 371	23, 079
Clover and timothy, alone or mixed	16, 211	13, 525	6, 020	13, 538
Other cultivated grasses	3, 966	12, 005	(1)	(1)
All other tame hay	53, 665	(1)	7, 426	4, 924
Wild hay	16, 314	11, 391	20, 143	20, 798
Small grains cut for hay	6, 227	5, 374	3, 858	3, 424
Annual legumes cut for hay	265	158	(1)	167
Potatoes	933	544	485	546
Apple ---------- trees	32, 052	16, 468	7, 069	4, 707
Apricot ---------- do	(1)	503	1, 363	1, 007
Cherry ---------- do	3, 905	2, 179	1, 161	697
Peach ---------- do	18, 834	11, 764	13, 492	6, 431
Pear ---------- do	1, 962	1, 136	756	1, 236
Plum and prune ---------- do	5, 038	2, 011	1, 222	866

[1] Not reported.

According to census reports, cropland in Baker County totaled 151,076 acres in 1950, and of this, 65,930 acres, or 43.6 percent, was in hay crops. A little less than 24 percent was in wheat and other grains not cut for hay or silage, and the rest of the cropland was in other crops and pasture or idle. This distribution is representative of conditions prevailing many years and shows the importance of hay crops in Baker County. In the early days almost all the hay was native grasses; but alfalfa hay now leads in acreage, wild hay is second, and clover-and-timothy hay is third. The total acreage in hay has decreased since 1919, the greatest drop being between 1919 and 1929.

Wheat is the leading small-grain crop, and barley is second. The acreage of oats has decreased steadily since 1919. Rye and corn occupy a relatively small area. Between 1919 and 1949 the acreage in various grain crops has fluctuated, but the total in grains had remained fairly constant.

Although some wheat and a small acreage of other grains are grown by dry farming, most of the wheat and nearly all the other crops are produced under irrigation. The yields on dry-farmed land are less than half of those on irrigated land. The wheat is grown as a cash crop, but most other crops are fed locally to cattle and sheep. Small acreages of dry beans, mostly of the red Rancho variety, are grown. Recently flax and crested wheatgrass have been grown for seed on a small scale.

Apples, peaches, other fruits, and berries are grown mostly for home use and local markets. Fruits do best on well-drained soils with a friable subsoil, and although land in the eastern part of the county is well suited, it is too far from shipping points to make large orchards profitable. The figures given in table 2 are for all of Baker County. Many of the peaches and apricots reported in the table are grown along the Snake River, which is outside of the area surveyed. Berries are grown to only a limited extent. The harvest report for 1949 listed 5 acres of strawberries. A few walnut and pecan trees were reported.

LIVESTOCK AND LIVESTOCK PRODUCTS

Stock raising and dairying are the types of farming most widely practiced in the Baker area. Feed crops thrive best in the area, and the valleys where these crops are grown are surrounded by areas of National forest and range land suitable for the summer grazing of many cattle and sheep. The number of livestock on the farms of Baker County is given in table 3 for stated years.

TABLE 3.—*Number*[1] *of livestock and beehives on farms in Baker County, Oreg., in stated years*

Livestock	1920	1930	1940	1950
	Number	*Number*	*Number*	*Number*
Cattle	57, 348	53, 361	50, 804	70, 562
Sheep	104, 255	177, 084	59, 229	61, 052
Horses	13, 185	8, 867	7, 971	4, 656
Mules	287	278	81	124
Hogs	7, 515	10, 651	9, 376	10, 000
Goats	31	65	306	(2)
Chickens	53, 332	55, 263	52, 815	35, 796
Other poultry	1, 848	(2)	1, 493	[3] 4, 283
Beehives	2, 000	820	1, 683	(2)

[1] For 1940, numbers of cattle, horses, and mules were over 3 months old on Apr. 1; swine, chickens, and other poultry over 4 months old on Apr. 1; and sheep over 6 months old on Apr. 1. For other years, number of livestock of all ages.
[2] Not reported.
[3] Turkeys raised.

Cattle lead all other livestock in importance and number; both dairy and beef types are raised. Practically all the feed for cattle is produced in the county. Almost all the dairy cattle are in the irrigated valleys. Jersey, Holstein-Friesian, and Guernsey are the main dairy breeds. In 1950, 5,706 milk cows were reported, and in the year preceding 4,339,690 pounds of whole milk and 739,267 pounds of butterfat were sold. Considerable quantities of butter and ice cream are sold locally, and the rest is shipped to outside markets to the east and west.

The beef cattle are grazed primarily on dry bunchgrass and sagebrush range and in the National forests, but some good herds of well-bred beef stock are pastured on irrigated land in the valleys. The Hereford is the leading beef breed. Most of the beef cattle are marketed at stockyards to the east.

Sheep are grazed on dry range and to a lesser extent in the National forests. They are pastured or fed in the valleys in winter. Most of the feed is produced within the county. Mountain-mahogany and other shrubs on the range supply some winter browse. For the lamb crops, ewes—principally of mixed Merino and Rambouillet breeds—are crossed with Hampshire or other mutton-type rams. The number of sheep on farms has decreased greatly since 1920. In 1949, 278,409 pounds of wool was shorn and 31,169 sheep and lambs were sold alive.

The number of swine on farms has fluctuated in the 1920–50 period, but there has been no great change. Chickens and other poultry are raised but not on a large scale.

Both draft and saddle horses are raised, many of the saddle horses for market. In the early days native strains were crossed with Kentucky saddlers, more recently they have been crossed with English Thoroughbred stallions. The result is an excellent type of saddle horse. The work stock is of high quality and the supply is adequate. The draft horses are mostly locally raised grade Percherons and Belgians.

TYPES AND SIZES OF FARMS

Census releases for 1950 classify the farms of Baker County as follows: 402 livestock, 131 dairy, 180 general, 91 field crop other than vegetables and fruit-and-nut farms, 22 poultry, and 6 fruit-and-nut. A total of 220 farms were listed as miscellaneous and unclassified. From these figures it is evident that beef raising, dairying, and general farming are the leading types of farm enterprise.

The early settlers depended largely on open range for pasture, but ranchers have acquired more and more of the public domain for grazing. According to census releases for 1950, the farms of the area range from less than 10 to 1,000 acres or more in size. The average size of all farms was 878.1 acres in 1950, as compared to 631.8 acres in 1940. The increase in average size of farms was accompanied by a decrease in number of farms. There were 208 fewer farms in 1950 than in 1940.

In 1950, there were 75 farms of less than 10 acres, and 203 farms of 1,000 acres or more. In that year there were 158 farms 10 to 49 acres in size; 128 farms, 50 to 99 acres; 151 farms, 100 to 179 acres; 76 farms, 180 to 259 acres; 135 farms, 260 to 499 acres; and 126 farms, 500 to 999 acres.

LAND USE

Approximately 923,733 acres, or 46.8 percent, of Baker County was in farms in 1950. Of the total area in farms, 151,076 acres, or 16.4 percent, was used as cropland; and 776,093, acres, or 77 percent, as pasture. Woodland not pastured and all other land in farms totaled 6.6 percent. A total of 104,000 acres of cropland was harvested in 1949, 28,068 acres was pastured, and 19,008 acres was not harvested or pastured.

FARM TENURE

Census reports for 1950 list 66.5 percent of the farms of Baker County as operated by full owners, 19.6 percent by part owners, 13.7 percent by tenants, and 0.2 percent by managers.

Share rental is the most common system of tenancy. The renter receives one-half of the hay and two-thirds of the grain. He furnishes the seed and all the labor, power, and machinery, and pays two-thirds of the cost for twine and threshing. Cash renters pay on an acreage basis, and the rental varies according to the quality of the land and the seniority of the water right.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of examining, classifying, and mapping soils in the field and recording their characteristics, particularly in reference to the growth of various crops, grasses, and trees.

The soils and the underlying materials are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, gullies, ditches, pits, and other excavations are studied. Each excavation exposes a series of distinct soil layers, or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is

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studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil and its content of lime, or calcium carbonate, and soluble salts are determined by simple tests. The drainage, both internal and external, and other external features, such as stoniness and the relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to the features influencing their adaptation for crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase. Some areas of land, such as Riverwash and Placer diggings, that have no true soil, are called (4) miscellaneous land types.

The series is composed of soils having the same genetic horizons, which are similar in important characteristics and arrangement in the soil profile and are developed from a particular type of parent material. Thus the series is made up of soils having essentially the same color, structure, and other important internal characteristics, the same natural drainage conditions, and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may differ within a series. The soil series are given names of places or geographic features near which they were first found. Baker, Ruckles, and Baldock are names of important soil series in this area.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Baldock silt loam and Baldock loam are soil types within the Baldock series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics.

Phases of a soil type are subdivisions of the type differing in some characteristics other than that of the soil profile, that may have an important practical significance. Differences in relief, stoniness, degree of accelerated erosion, and depth to loose gravel frequently cause soil types to be separated into phases. For example, within the normal range of relief for a soil type, certain parts may have slopes gentle enough to permit the use of machinery and the growth of cultivated crops and other parts may not. In such an instance the more sloping parts of the soil type may be shown on the map as a sloping or hilly phase, as, for example, Baker silt loam, hilly phase. Similarly, soils having differences in degree of accelerated erosion may be separated into phases.

Some of the terms mentioned in this report are in common use and need no explanation. Others have special meaning in soil science.

For example, *texture* refers to the relative quantities of clay, silt, and various size classes of sand and coarser particles making up the soil mass. Light- or coarse-textured soils contain much of the coarser separates (sand), and heavy- or fine-textured soils contain much clay. *Structure* refers to the natural arrangement of the soil material into aggregates, structural particles, or masses. *Consistence* refers to such conditions as hardness, friability, plasticity, stickiness, and cementa-

tion. *Permeability* and *perviousness* connote the ease with which water, air, and roots penetrate the soil.

Surface soil ordinarily refers to the surface layer (or upper 2 or 3 layers), which in this area usually ranges from 5 to 15 inches in thickness and contains the maximum accumulation of organic matter. Ordinarily, it is more granular or crumblike than the subsoil. The layer just below the surface soil, which generally is more clayey, stronger in color, more blocky or prismatic, and of lower organic-matter content, is called the *subsoil.* In this area, its thickness ranges from 10 to 30 inches. The *substratum* is beneath the subsoil.

Simple chemical tests show the *reaction* of the soil or how *alkaline* or *acid* it may be.[5] The presence or absence of *lime* (free calcium carbonate) is detected by the application of unheated dilute hydrochloric acid. *Calcareous* soils are those containing sufficient free calcium carbonate (often with magnesium carbonate) to fizz, bubble, or effervesce visibly to the naked eye when the unheated dilute hydrochloric acid is applied, whereas *noncalcareous* soils do not contain enough free calcium carbonate to be detected by this treatment. A soil may contain an abundance of available calcium in other forms and not be calcareous in the forgoing sense. The term "lime" refers to free calcium carbonate and not to calcium in other forms.

A *saline soil* is one containing soluble salts in such quantities and so distributed in the profile that they interfere with most crop plants. The total content of readily soluble salts is estimated by the use of the electrolytic bridge. The salts may be neutral or strongly alkaline in reaction. An *alkali* soil is one having so high a degree of alkalinity, exchangable sodium content, or both, as to interfere with most crop plants. Alkali soils usually have a pH of 8.5 or higher. Soils may be both saline and strongly alkaline.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types in relation to roads, houses, streams, lakes, section lines, and other local cultural and natural features of the landscape.

SOILS OF THE BAKER AREA

Soils are developed by soil-forming forces acting on the parent material. The major forces are climate, vegetation, and associated biologic activity. The time during which these forces have acted on the parent material is an important factor.

The predominant soils of the Baker area have developed under a cover of grass and sagebrush in a semiarid temperate climate. At the moister higher altitudes the soils have formed under a cover of ponderosa pine and other trees that have influenced their development.

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[5] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value (*10*). A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. Indicator solutions are used to determine the reactions of the soil. Terms that refer to reaction and are commonly used in this report are as follows:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6–7.3
Very strongly acid	4.5–5.0	Mildly alkaline	7.4–7.8
Strongly acid	5.1–5.5	Moderately alkaline	7.9–8.4
Medium acid	5.6–6.0	Strongly alkaline	8.5–9.0
Slightly acid	6.1–6.5	Very strongly alkaline	9.1 or higher

Other soils have developed in Pine and Sumpter Valleys under a moderate precipitation and a vegetation of mixed grass, trees, and shrubs.

The parent materials of the soils in the valley floors and high benches are largely stream and lake deposits derived from a variety of rocks. The bordering hilly areas and some of the benches are underlain by a variety of rocks, including basalt, andesite, rhyolite, granite, argillite, greenstone, and others.

Soils formed from recently deposited material on the valley floors have little soil development and generally have a friable subsoil that is permeable to moisture and easily penetrated by plant roots. Soils developed from somewhat older material, as on lower terraces, ordinarily have a moderate development, a somewhat compact upper subsoil, and a concentration of lime in the lower subsoil in semiarid areas. Soils developed from old material, as on the high terraces and smooth areas underlain by bedrock, have a strongly developed profile and a very compact, very slowly permeable subsoil.

The well-drained soils in Baker, Eagle, and Lower Powder Valleys, generally have a grayish-brown, light brownish-gray, or pale-brown surface soil; a brown heavy (or fine-textured) upper subsoil of yellowish or reddish cast; and a compact calcareous lower subsoil that rests on the parent material. The surface soils are grayish-brown when dry but are dark grayish-brown when moist. Soils with deficient drainage are dark where relatively free of excess soluble salts or of alkali. Most areas with deficient drainage, however, are affected by an excess of soluble salts or alkali and have a light grayish-brown surface soil and a compact highly calcareous similar colored subsoil. Soils in timbered areas have a lighter colored surface soil covered with dark organic material, and a brown, yellowish-brown, or reddish-brown subsoil.

Except where the parent material consists of recent coarse alluvium, the soils in Pine and Sumter Valleys have a somewhat darker brown surface soil and a finer textured upper subsoil than soils in the other valleys. These soils are noncalareous and free of alkali.

In the Baker area the texture of the soil is closely related to the parent material. Loams and silt loams are common where the parent material is from mixed granite, lava, and metamorphic rocks, as in much of Baker, Sumpter, and Lower Powder Valleys. Rather coarse loams, gravelly loams, and stony loams predominate where the soil was developed from granitic materials, as in the northwestern part of Baker Valley, the north-central part of Pine Valley, and in Eagle Valley. Clay loams predominate where the parent material is weathered basalt, as on the outer borders of Eagle and Pine Valleys. Loam soils are common in areas underlain by greenstone, as in the belt north of Lower Powder Valley. Soils developed from argillite are mostly loams where developed under a cover of timber, and gritty clay loams where the vegetation is sagebrush and grass.

Except in Eagle Valley, soil erosion has not been a serious problem on cultivated land, for most of the irrigated tracts are fairly smooth. In Eagle Valley much strongly sloping land is irrigated because water is abundant. As a consequence, considerable sheet erosion and some gully erosion have occurred. The hilly range lands have nearly all suffered some erosion resulting from prolonged overgrazing.

SOIL SERIES AND THEIR RELATIONS

The soil series of the Baker area are placed in three main groups, principally on the basis of physiography, as follows: (1) Soils of uplands; (2) soils of older terraces, alluvial fans, and lake basins; and (3) soils of bottom lands and recent alluvial fans. The soil series of each of these three groups are divided ino several subgroups on the basis of their content of lime, color, texture, consistence, natural vegetation, and drainage.

SOILS OF UPLANDS

The soils of the uplands cover large areas but are of low productivity. Common features of these soils are a more or less stony surface soil and a bedrock substratum at rather shallow depths. These soils naturally fall into three subgroups according to their natural vegetation and color of surface soil.

LIGHT-COLORED SOILS FORMED UNDER GRASS AND SAGEBRUSH

The light-colored upland soils formed under grass and sagebrush are members of the Durkee, Glasgow, Lookout, North Powder, and Ruckles series. They have light brownish-gray, pale-brown, or grayish-brown surface soils and more or less calcareous subsoils. The soils have developed under an annual precipitation ranging from 9 to 14 inches. Grazing is the principal use.

The Ruckles and Lookout soils formed over basalt or other lava rock; the North Powder, over biotite-quartz diorite; the Glasgow, over volcanic tuff or diatomite; and the Durkee, over argillite. The Lookout soils have a caliche, or lime, hardpan, but the others do not.

DARK-COLORED SOILS FORMED UNDER GRASS, SAGEBRUSH, OR SHRUBS

The dark-colored upland soils formed under grass, sagebrush, or shrubs—those of the Brownlee, Clover Creek, Gem, Keating, Mehlhorn, and Turnbow series—have dark grayish-brown, dark-gray, grayish-brown, or slightly dark-brown surface soils. In general the soils of this subgroup have developed under a somewhat higher rainfall than the light-colored soils of the previous subgroup, and their surface soils are more granular and contain more organic matter. The annual precipitation ranges from 12 to 25 inches.

Only the Clover Creek and Gem soils have a calcareous lower subsoil. The lack of lime in the bedrock may partly account for the lack of a layer of carbonate accumulation in the subsoils of some of the other soils. The Brownlee soils have formed over albite granite, the Clover Creek soils over hard limestone, the Keating soils over greenstone, and the Turnbow soils over serpentine bedrock. The Gem and Mehlhorn soils have formed over basalt and other volcanic rocks. The Gem soils have a layer of lime accumulation in their lower subsoil; the Mehlhorn soils have a noncalcareous subsoil. The soils of this subgroup are used principally for grazing.

SOILS FORMED UNDER CONIFEROUS FOREST

The upland soils formed under coniferous forest are members of the Moscow, Kilmerque, Rouen, and Underwood series. They are noncalcareous and somewhat acid. In general they have developed

under higher rainfall than soils of the two preceding subgroups of upland soils. The annual precipitation is 18 to 45 inches. The Moscow soils formed over albite granite; the Kilmerque, over biotite-quartz diorite; the Underwood, over basalt or andesite; and the Rouen, over argillite.

SOILS OF OLDER TERRACES, ALLUVIAL FANS, AND LAKE BASINS

The soils of older terraces, alluvial fans, and lake basins occur on high, medium, or moderately low terraces, alluvial fans, or old lake basins. They have formed from water-laid materials (principally older alluvium and lake-laid deposits) derived from a variety of sources. Except for some of the Halfway soils, which are imperfectly to moderately well drained, they are adequately drained for the common crops. This group is subdivided into nine subgroups on the basis of profile development, the texture and consistence of the subsoil, the color of the surface soils, and the natural vegetation.

LIGHT-COLORED SOILS WITH HARDPAN, FORMED UNDER SAGEBRUSH AND GRASS

The light-colored soils with hardpan, formed under a cover of sagebrush and grass, are members of the Barnard and Virtue series. They are old, have a hardpan in the subsoil that is very slowly permeable or impermeable to water and roots, and have formed on stratified unconsolidated alluvium or weakly consolidated deposits. The annual precipitation ranges from 9 to 13 inches. The Virtue soils overlie unconsolidated old mixed alluvium; the Barnard, semiconsolidated gravel, clay, tuff, diatomite, and basalt. The soils of the subgroup are used for grazing or irrigated hay and grains.

DARK-COLORED SOILS WITH HARDPAN, FORMED UNDER GRASS AND SAGEBRUSH

The dark-colored soils with hardpan, formed under grass and sagebrush, are of the Bulger and Salisbury series. The surface soil is somewhat dark-colored and the hardpan occurs in the subsoil. These soils receive an average annual precipitation of 12 to 15 inches. They occur on terraces or old alluvial fans and are noncalcareous or only slightly calcareous in their lower subsoils. The Bulger soil is derived mostly from old granitic and quartzitic alluvium, whereas the Salisbury soils are derived chiefly from old mixed coarse alluvium composed mainly of argillite mixed with basaltic and granitic materials.

LIGHT-COLORED SOILS WITH FINE-TEXTURED SUBSOIL, FORMED UNDER SAGEBRUSH AND GRASS

The light-colored soils with fine-textured subsoil, formed under sagebrush and grass, are members of the Baker and Hutchinson series. They have a fine-textured slowly or very slowly permeable subsoil over stratified older alluvium and occur on terraces and old alluvial fans. They receive an annual precipitation of 9 to 14 inches. The Baker soils have a calcareous lower subsoil, whereas the Hutchinson soils are noncalcareous in most places and are derived to a greater extent from granitic materials. The soils of this subgroup are used for irrigated hay and grains, dry-farmed grains, and grazing.

DARK-COLORED SOILS WITH FINE-TEXTURED SUBSOIL, FORMED UNDER GRASS AND SAGEBRUSH

The dark-colored soils with fine-textured subsoil, formed under grass and sagebrush, are those of the Hibbard and Ladd series. The fine- or moderately fine-textured subsoil is very slowly to moderately permeable and lies over stratified old alluvium. These soils occur on terraces and old alluvial fans. The annual precipitation is 13 to 16 inches.

The Hibbard soils have a calcareous lower subsoil and are derived from old mixed alluvium, mostly argillitic and quartzitic in origin. The Ladd soils are noncalcareous in most places and are derived largely from old granitic or dioritic alluvium. The soils of this subgroup are used for dry-farmed grains, irrigated alfalfa and grains, and grazing.

LIGHT-COLORED SOILS WITH FINE-TEXTURED SUBSOIL, FORMED UNDER GRASS, BITTERBRUSH, AND A FEW TREES

The light-colored soils with fine-textured subsoil, formed under grass, bitterbrush, and a few trees, are members of the Applegate series. They have a relatively light-colored or brown surface soil and a noncalcareous subsoil. They occur on terraces and old alluvial fans.

DARK-COLORED SOILS WITH FINE-TEXTURED SUBSOIL, FORMED UNDER GRASS AND A FEW TREES

The dark-colored soils with fine-textured subsoil, formed under a vegetative cover composed of grass and a few trees, are those of the Halfway series. The fine- or moderately fine-textured subsoil lies over stratified old alluvium and occurs on terraces and old alluvial fans. The annual precipitation ranges from 17 to 25 inches. Drainage is imperfect to moderately good, and the soils are used mostly for irrigated hay and grains and pasture.

LIGHT-COLORED SOILS WITH MODERATELY FINE-TEXTURED SUBSOIL, FORMED UNDER PINES

The light-colored soils with moderately fine-textured subsoil, formed under pines, are members of the McEwen series. They have a brown, pale-brown, or grayish-brown acid surface soil under a thin layer of forest litter. The subsoil is noncalcareous. The McEwen soils occur on terraces and low alluvial fans.

DARK-COLORED SOILS WITH MEDIUM-TEXTURED SUBSOIL, FORMED UNDER GRASS, SHRUBS, AND A FEW TREES

The dark-colored soils with a medium textured moderately or rapidly permeable noncalcareous subsoil, developed under a cover of grass, shrubs, and a few trees, are members of the Langrell series. They formed under an annual precipitation of 17 to 25 inches and are used for irrigated hay and grains and pasture.

LIGHT-COLORED SOILS WITH COARSE-TEXTURED SUBSOIL, FORMED UNDER PINES

The light-colored soils with coarse-textured subsoil, formed under pines, are members of the Springdale series. They have a rapidly

or very rapidly permeable noncalcareous subsoil and occur on terraces and alluvial fans. The annual precipitation is 12 to 20 inches. Soils of the Springdale series are used for irrigated alfalfa and grains, grazing, and forestry.

SOILS OF BOTTOM LANDS AND RECENT ALLUVIAL FANS

Soils of the bottom lands and recent alluvial fans occur on valley floors. They may occur on stream bottom lands, low alluvial fans, or very low terraces. They are forming in recent alluvial materials of diverse origin. The soils of this group are placed in four subgroups on the basis of color of surface soil, drainage, and natural vegetation.

LIGHT-COLORED WELL-DRAINED SOILS FORMED UNDER GRASS AND SAGEBRUSH

The light-colored well-drained soils formed under grass and sagebrush are members of the Onyx and Powder series. They are well drained to moderately well drained, occur on valley floors, and are used for irrigated alfalfa and grains and grazing.

LIGHT-COLORED IMPERFECTLY OR POORLY DRAINED SOILS FORMED UNDER GRASS AND SHRUBS (SLIGHTLY AFFECTED BY ALKALI)

The light-colored imperfectly or poorly drained soils slightly affected by alkali and having a natural vegetation of grass and shrubs are members of the Baldock, Balm, and Gooch series. They have a calcareous surface soil and subsoil, and a slight excess of soluble salts may be present. The soils are forming in stratified water-laid materials on valley floors. The annual precipitation is 9 to 13 inches. The Baldock subsoil is medium-textured; the Gooch, fine-textured; and the Balm, coarse-textured. The soils of this subgroup are used for irrigated hay and grains or for grazing.

LIGHT-COLORED IMPERFECTLY OR POORLY DRAINED SOILS FORMED UNDER SALTGRASS AND GREASEWOOD OR SAGEBRUSH (STRONGLY AFFECTED BY ALKALI)

The light-colored imperfectly or poorly drained soils strongly affected by alkali and developed under saltgrass and greasewood or sagebrush are members of the Haines, Stanfield, Umapine, and Lun series. These soils occur on valley floors, have a calcareous subsoil, and formed under salt-loving or alkali-tolerant grasses and some shrubs. The annual precipitation is 9 to 13 inches. The Stanfield soil has a lime hardpan; the Lun and Umapine have a weakly or feebly developed hardpan. The Lun has fine-textured upper subsoil. The Haines are very light-colored soils with volcanic ash in the lower part of their profile.

DARK-COLORED IMPERFECTLY OR POORLY DRAINED SOILS FORMED UNDER GRASS AND A FEW SHRUBS OR TREES

The dark-colored imperfectly or poorly drained soils formed under grass and a few shrubs or trees are those of the Catherine, Hershal, and Wingville series. They have dark or moderately dark surface soils and permeable subsoils and were formed on valley floors from mixed alluvial materials. The annual precipitation is 10 to 30 inches. The Catherine and Hershal soils are noncalcareous; the Wingville, calcareous. The Hershal soils are not so dark and are more poorly

drained than the others of this subgroup. All the soils of the subgroup are used for hay and grains under irrigation.

SOIL DESCRIPTIONS

The soil series, types, and phases[6] occurring in the Baker area are described in detail in the following pages and their agriculture is discussed. Their location and distribution are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 4. The soil types and phases are identified by the same symbols as those on the map.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in the Baker area, Oreg.*

Soil	Acres	Percent	Soil	Acres	Percent
Applegate clay loam	1,835	0.3	Durkee stony clay loam	5,950	1.1
Hilly phase	332	.1	Eroded phase	1,509	.3
Baker silt loam	23,079	4.4	Eroded steep phase	1,203	.2
Coarse-textured subsoil phase	1,632	.3	Steep phase	5,208	1.0
Eroded hilly phase	825	.2	Gem clay	1,898	.4
Eroded phase	3,926	.7	Eroded phase	2,520	.5
Hilly phase	487	.1	Eroded steep phase	1,057	.2
Level phase	818	.2	Steep phase	98	(1)
Sloping phase	31	(1)	Glasgow silt loam	937	.2
Baldock loam	6,637	1.3	Eroded hilly phase	110	(1)
Gravelly subsoil phase	112	(1)	Eroded phase	151	(1)
Baldock silt loam	10,781	2.1	Gently sloping phase	327	.1
Balm loam	1,326	.3	Hilly phase	345	.1
Balm gravelly sandy loam	1,518	.3	Glasgow stony loam	292	.1
Barnard clay loam	1,744	.3	Eroded hilly phase	36	(1)
Eroded hilly phase	512	.1	Eroded phase	50	(1)
Eroded phase	229	(1)	Eroded steep phase	38	(1)
Hilly phase	1,100	.2	Hilly phase	400	.1
Brownlee loam	409	.1	Steep phase	198	(1)
Eroded phase	12,370	2.4	Glasgow stony soils	1,121	.2
Eroded shallow phase	7,502	1.4	Gooch silt loam	3,020	.6
Eroded steep phase	6,008	1.1	Gooch silty clay loam	2,200	.4
Shallow phase	162	(1)	Alkali phase	2,061	.4
Bulger silt loam	942	.2	Gravel pits	7	(1)
Catherine loam	3,035	.6	Haines silt loam	7,848	1.5
Catherine silt loam	887	.2	Halfway clay	1,274	.2
Catherine silty clay loam	1,497	.3	Halfway clay loam	3,053	.6
Gravelly subsoil phase	210	(1)	Halfway silt loam	1,134	.2
Overwash phase	2,444	.5	Hershal silt loam	1,090	.2
Clover Creek loam	22	(1)	Gravelly subsoil phase	1,370	.3
Clover Creek stony loam	270	.1	Hibbard clay	3,726	.7
			Eroded moderately steep phase	107	(1)
			Eroded phase	980	.2
			Moderately steep phase	326	.1

See footnote at end of table.

[6] Where two or more soils of a type are mapped, one of them without a phase designation, that one having no designation may be referred to as the normal phase of the type.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in the Baker area, Oreg.*—Continued

Soil	Acres	Percent
Hibbard clay loam	615	.1
Eroded phase	135	(1)
Hibbard silt loam	1,592	.3
Eroded phase	413	.1
Hilly phase	309	.1
Hibbard stony clay	570	.1
Eroded moderately steep phase	798	.2
Eroded phase	1,019	.2
Eroded steep phase	231	(1)
Moderately steep phase	506	.1
Hutchinson loam	3,109	.6
Shallow phase	2,139	.4
Keating loam	4,686	.9
Deep phase	900	.2
Eroded hilly phase	7	(1)
Eroded steep phase	5	(1)
Gently sloping phase	1,777	.3
Hilly phase	1,003	.2
Keating stony loam	14,327	2.7
Eroded phase	319	.1
Eroded steep phase	413	.1
Gently sloping phase	238	(1)
Sloping phase	119	(1)
Steep phase	2,255	.4
Kilmerque loam	1,285	.2
Hilly phase	608	.1
Kilmerque sandy loam	996	.2
Eroded steep phase	428	.1
Hilly phase	1,416	.3
Ladd loam	3,346	.6
Alluvial-fan phase	3,596	.7
Deep phase	689	.1
Hilly phase	687	.1
Langrell gravelly loam	4,895	.9
Langrell loam	2,052	.4
Lookout clay loam	5,346	1.0
Eroded hilly phase	126	(1)
Eroded phase	227	(1)
Hilly phase	600	.1
Lookout stony clay loam	20,200	3.8
Eroded hilly phase	8,187	1.6
Eroded phase	5,970	1.1
Hilly phase	13,145	2.5
Lun silt loam	1,222	.2
McEwen loam	7,270	1.4
Deep phase	583	.1
Moderately steep phase	305	.1
Overwash phase	251	(1)
Mehlhorn clay loam	2,696	.5
Hilly phase	230	(1)
Mehlhorn stony clay loam	4,511	.9
Eroded hilly phase	4,015	.8
Eroded phase	5,548	1.1
Eroded shallow phase	782	.1
Eroded steep phase	2,239	.4
Hilly phase	161	(1)
Moscow loam	459	.1
Eroded phase	197	(1)
Eroded steep phase	190	(1)
Steep phase	299	.1
Muck	170	(1)
North Powder loam	5,944	1.1
Eroded hilly phase	530	.1
Eroded phase	711	.1
Eroded shallow phase	4,290	.8
Onyx silt loam	4,510	.9
Alluvial-fan phase	1,035	.2
Eroded alluvial-fan phase	107	(1)
Gravelly subsoil phase	1,336	.3
Placer diggings	1,403	.3
Powder silt loam	4,454	.8
Riverwash	279	.1
Rouen stony loam	3,039	.6
Steep phase	4,146	.8
Rough broken and stony land	78,741	15.2
Ruckles loam	17,310	3.3
Deep phase	1,167	.2
Eroded hilly phase	3,050	.6
Eroded phase	2,390	.5
Eroded steep phase	521	.1
Hilly phase	4,976	1.0
Steep phase	331	.1
Ruckles stony loam, eroded steep phase	4,989	1.0
Salisbury gravelly loam	3,036	.6
Salisbury stony loam	2,196	.4
Springdale fine sandy loam	4,401	.8
Springdale gravelly sandy loam	3,685	.7
Springdale stony sandy loam	1,133	.2
Springdale very fine sandy loam	4,033	.8
Stanfield silt loam	5,391	1.0
Turnbow stony clay	99	(1)
Eroded phase	423	.1
Umapine silt loam	8,041	1.5
Underwood loam	3,862	.7
Steep phase	4,847	.9

See footnote at end of table.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in the Baker area, Oreg.*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Underwood stony loam	350	.1	Virtue silt loam—Con.		
Virtue cobbly loam	985	.2	Moderately steep phase	173	(1)
Eroded moderately steep phase	1,831	.3	Sloping phase	154	(1)
Eroded phase	2,012	.4	Wingville silt loam	10,066	1.9
Virtue silt loam	11,534	2.2	Porous subsoil phase	90	(1)
Deep phase	5,509	1.0	Wingville silty clay loam	6,238	1.2
Eroded moderately steep phase	499	.1	Gravelly subsoil phase	880	.2
Eroded phase	10,800	2.1			
Eroded sloping phase	119	(1)			
Level phase	416	.1	Total	524,800	100.0

[1] Less than 0.1 percent.

APPLEGATE SERIES

Soils of the Applegate series occur on nearly level to gently sloping well-drained alluvial fans and terraces under a cover of grass and scattered aspen, ponderosa pine, and other trees and shrubs in an area having an annual precipitation of 17 to 25 inches. The parent material is old mixed alluvium derived from basaltic, granitic, and some metamorphic rock materials or soils formed thereon. These soils resemble the associated Mehlhorn soils but overlie unconsolidated transported material rather than bedrock and have a heavier textured, tougher, and more compact subsoil. Applegate soils somewhat resemble the McEwen but are darker and typically were originally grass-covered rather than timbered. They have a heavier textured more strongly developed subsoil than the associated Langrell soils.

Applegate clay loam (2–15% slopes) (AA).—This soil is associated with the Mehlhorn and Langrell soils just below the pine forests. The dominant range in slope is from 3 to 7 percent. There has been little erosion in most places. The soil does not contain free lime or excess soluble salts. The surface soil is slightly acid to neutral; the subsoil, slightly acid; and the lower layers, neutral. The water-holding capacity is good. The subsoil is slowly permeable to water. Some roots penetrate the compact layers of the profile. The natural vegetation is mainly grass and scattered aspen, haw, ponderosa pine, and other shrubs and trees. There is some bitterbrush but no sagebrush.

Profile description.—The upper part of the surface soil consists of about 8 inches of brown to dark brown or slightly dark reddish-brown clay loam containing a few pebbles and cobblestones and a moderate quantity of organic matter. The material—dark reddish brown or dark brown when moist—breaks into irregular nut- or pea-sized aggregates easily crumbled when dry but sticky when wet. This

layer grades between 8 to 18 inches into brown or slightly reddish-brown heavy clay loam containing some rounded gravel and cobblestones. This heavy clay loam is hard when dry and breaks into irregularly shaped aggregates when disturbed.

The subsoil, between the depths of about 18 and 40 inches, is reddish-brown tough compact clay in which many rounded cobblestones and pebbles are imbedded. There are many yellowish-brown streaks from decayed rock and a large number of fine holes or old root channels. The layer is difficult to penetrate. The lower subsoil, between depths of 40 to 60 inches, is light yellowish-brown somewhat compact sticky gravelly loam containing many rounded cobblestones. The material is sandier and more permeable as depth increases.

Below about 60 inches is the substratum—light yellowish-brown coarse gravelly and cobbly alluvium with interstratified layers of fine material. The pebbles and cobblestones are mostly basaltic and granitic, and many of them are strongly weathered, partly disintegrated, and rather soft.

Included with this soil is an area southwest of Pine where the surface soil is too stony to cultivate.

Use and management.—About 80 percent of Applegate clay loam is cultivated under irrigation, mostly for hay and grain. Because of fairly abundant irrigation water, little dry-farming is done. Uncleared areas produce good grazing. The soil is fairly productive.

Applegate clay loam, hilly phase (15–30% slopes) (AB).—This phase differs from Applegate clay loam chiefly in having steeper relief. In most other features it is similar to Applegate clay loam, but in many places it is somewhat more variable, heavier textured, more sticky, and higher in content of stones and gravel in the surface soil. This phase occurs on the more sloping parts of terraces and on slopes below the tops of high benches.

Use and management.—This hilly phase is not cultivated but a small acreage has been irrigated to increase its grazing value. It provides good grazing under range conditions. Some accelerated soil erosion has occurred following overgrazing.

BAKER SERIES

Soils of the Baker series are among the most extensive in the area. The larger tracts are in Baker Valley, and smaller bodies are in the area to the east. The soils are well drained and have developed in old alluvial and lake-laid materials under a cover of grass and big sagebrush in a semiarid climate having an annual precipitation of 9 to 14 inches. Usually the ground freezes during winter. Below an average depth of 60 inches the materials are irregularly stratified layers of coarse and fine alluvium. The parent materials are of mixed origin and are derived from basalt, argillite, granite, gabbro, metagabbro, rhyolite, quartzite, and other metamorphic and igneous rock and soils formed thereon. In places the upper few inches of the soil may be derived from loess. The Baker soils differ from the associated Virtue soils in having a less strongly developed and more permeable subsoil and lack the lime hardpan typical of the Virtue soils.

Baker silt loam (2–7% slopes) (BA).—This is one of the more important soils of the area because of its large aggregate acreage, great proportion under cultivation, favorable relief and location for irriga-

tion, and moderate to high productivity. It occurs principally on well-drained alluvial fans and terraces, slightly dissected by natural stream erosion, and less commonly on strongly dissected high areas of old materials. Surface runoff is medium. The soil has a good water-holding capacity. The subsoil is slowly permeable to water and roots. Most of the soil is free from excess soluble salts and alkali. In places there is a trace of soluble salts in the lower subsoil, but not enough to interfere with plant growth. The natural vegetation was big sagebrush, grasses, and some rabbitbrush, other shrubs, and flowering plants. The vegetation is now largely sagebrush. In many places this soil is closely associated with Onyx silt loam, alluvial fan phase.

Profile description.—The surface soil is grayish-brown to light brownish-gray friable silt loam to a depth of about 6 inches. It is moderately low in organic matter. When dry and undisturbed the surface inch is somewhat vesicular, that in the next lower 1 or 2 inches is somewhat platy, and that in the next few inches is massive or single-grained. The surface soil is neutral or slightly acid and noncalcareous. From 6 to about 13 inches occurs the lower surface soil, which is similarly colored friable silt loam that breaks into fine or very fine granules. When moist the surface layers are dark grayish brown to very dark brown.

The upper subsoil from 13 to 20 inches is pale-brown or grayish-brown prismatic compact clay loam or clay. It breaks into fine nutlike aggregates that are very hard when dry. Roots follow cracks and structural planes. The material is dark grayish brown to dark brown when moist. In most places it is mildly to moderately alkaline and noncalcareous. From 20 to 30 inches it grades into brown, pale-brown, or yellowish-brown, compact clay loam containing some streaks and spots of white lime. This material breaks into moderately distinct fine nutlike aggregates which are hard and rather difficult to remove. It is more yellowish and limy with increase in depth and is dark grayish brown to brown when moist.

The lower subsoil, between depths of 30 and 45 inches, is light yellowish-brown to pale-brown mildly to moderately alkaline compact loam containing much segregated lime. It may be weakly cemented in places but can be readily penetrated with a shovel or an auger and breaks into small harsh angular fragments. This layer is underlain by somewhat compact light yellowish-brown or pale-brown loam containing more or less segregated lime.

The upper substratum from 45 to 60 inches is less calcareous with increase in depth, ranges from heavy loam to sandy loam in texture, and in places includes some gravel or layers of clay loam. Below 60 inches the substratum consists of stratified layers of pale-brown or light yellowish-brown gravelly loam, sandy loam, and finer material.

In many areas the surface soil is a loam, and there is considerable variation in the thickness and compactness of the upper and lower subsoil layers. In places both of these layers are nearly as slowly permeable and compact as the corresponding ones in Virtue silt loam.

Included with Baker silt loam are many areas having a less compact upper subsoil, more of a cemented lime layer, and a more gravelly substratum than typical. These included soils total about 3¼ square miles and occur mostly in Eagle Valley. They have a grayish-brown or light brownish-gray loam or silt loam surface layer about 12 inches

thick. The upper subsoil is grayish- or pale-brown noncalcareous firm heavy silt loam or heavy loam that breaks into easily crumbled nutlike aggregates. At about 3 feet the subsoil is pale-brown or light yellowish-brown compact gritty clay loam containing much segregated white lime. This layer is 6 to 24 inches thick and ranges from very weakly cemented to strongly cemented lime hardpan. In most places, however, it is fragmentary and easily shattered. The cemented layer is underlain by light yellowish-brown calcareous loam that grades into stratified and compact gravel, sand, and cobblestones containing some finer material. The depth to the gravel ranges from 3 to 6 feet. These included areas have a good water-holding capacity and are permeable above the hardpanlike layer.

Also included with Baker silt loam are many areas having a less well-developed profile in which the subsoil is less compact, less clayey, and more permeable. These areas occupy a total of about 8 square miles. The larger ones are west of Haines and north of North Powder, and several are in Lower Powder Valley. These included areas are associated with the typical soil and Onyx silt loam, alluvial-fan phase. Most are gently sloping, but small areas in Lower Powder Valley are strongly sloping. The soil of the included areas has a grayish- or pale-brown calcareous slightly to moderately compact firm heavy loam, heavy silt loam, or clay loam subsoil, which is somewhat more yellowish below a depth of 30 inches. At a depth of about 60 inches the substratum grades into irregularly stratified layers of gravel, sand, gravelly loam, and loam containing some rounded cobblestones. Indicated on the soil map by gravel symbols are a few areas where the soil is somewhat gravelly and shallower than described. The soil of these areas is permeable and good in water-holding capacity.

Small areas southwest and northwest of Baker, totaling about half a square mile, have a deeper surface soil than typical. These areas consist of sloping alluvial fans and colluvial slopes where the original soil has been covered with some overwash from higher lying land. The depth of the surface soil ranges from 15 to 30 inches.

Use and management.—About 70 percent of Baker silt loam is under cultivation, and nearly all of this is irrigated. Alfalfa and wheat are the principal crops. Soft Federation is the most common variety of wheat. Some oats and barley are grown. Little commercial fertilizer and manure have been used. Sulfur applied at the rate of 500 pounds an acre has resulted in increased yields. Owing to the smooth relief, accelerated erosion has not been severe, but some areas on exposed benches show a small amount of wind erosion. The slopes are favorable for irrigation. Yields are about average for irrigated land in the area.

Uncleared areas are used for natural pasture. Among the practices that would increase the yield of pasture are proper stocking to prevent overgrazing, the deferring of spring grazing until new growth is ready, development of water supplies, and proper placing of salt on ranges so as to obtain better grazing distribution.

The included soils in Eagle Valley that have a less heavy and more permeable upper subsoil are somewhat different from the normal soil in crop suitabilities and are generally somewhat higher in productivity. Eagle Valley lies at a considerable lower altitude than Baker Valley, and the included soils occurring there are some of the

most productive of the area. Furthermore, there is an abundant supply of water for irrigation. On these soils alfalfa has been the main crop; it produces 3 cuttings a year and an average yield of 4¼ tons an acre. As many as 8 tons of alfalfa an acre were formerly produced, but yields are now lower because of decreased fertility and the damage caused by wilt and the alfalfa weevil. Clover is now replacing alfalfa. Apples do well and are of excellent quality if properly sprayed; but because of the long distance to shipping points, they are grown only for local markets. Corn produces about 12 tons of silage or about 50 bushels of grain an acre. Cane fruits, potatoes, and other crops do well. In places, use of too much water on these soils has increased leaching and decreased fertility.

The included soils that have less well-developed profiles and a less compact and more permeable subsoil than typical and occur mainly west of Haines and north of North Powder are somewhat more productive than Baker silt loam. Under irrigation these soils produce about 4 tons an acre of alfalfa in two cuttings, 35 bushels of wheat, 40 of oats, and 35 of barley. Wheat grown after summer fallow without irrigation yields about 18 bushels an acre.

Baker silt loam, eroded phase (2–12% slopes) (BD).—In most features this phase is similar to Baker silt loam, but its surface soil is somewhat shallower and more irregular in depth. A little more than 25 percent of the surface soil has been lost through sheet erosion, and there are a few shallow gullies, most of which are shown by symbols on the soil map. Only a few areas have been severely eroded.

Use and management.—This phase is used principally for range pasture and is of average suitability. Grazing should be rigidly controlled to prevent further damage to the range and to allow the grasses to become better established. Better growth of the plants will decrease soil erosion. Only a small part of this phase is cultivated, and yields are somewhat lower than on Baker silt loam. The soil should be irrigated carefully to prevent further erosion.

Baker silt loam, level phase (0–2% slopes) (BG).—All of this phase is cultivated. It has smoother relief than Baker silt loam, but most other features are similar. The likelihood of erosion is less than on Baker silt loam. Surface drainage is slow but generally adequate. Use and management practices are similar to those for Baker silt loam, but yields obtained are slightly higher.

Baker silt loam, sloping phase (7–12% slopes) (BH).—This phase has steeper slopes than Baker silt loam but is otherwise similar. It occurs on slopes below higher terraces and is all in cultivation. Use and management practices are similar to those for Baker silt loam, and yields are slightly less. The soil should be cultivated on the contour, and special care in irrigation is needed to prevent erosion. To the greatest extent possible, this phase should be used for hay and pasture.

Baker silt loam, hilly phase (12–25% slopes) (BF).—Confined principally to small bodies in ravines or to slopes below high benches, this phase is steeper, somewhat more stony and gravelly, and more variable in depth than Baker silt loam. Slopes as steep as 30 percent in the Baker Valley are included. The soil is susceptible to erosion and has been slightly eroded in most areas.

About 80 acres that differ somewhat from this phase are included. These soils occur mainly in Eagle Valley. The upper subsoil, a heavy loam or clay loam, grades into weakly cemented limy gravelly hardpan. The hardpan, 1 to 2 feet thick, grades irregularly into stratified gravel containing lenses of fine material and in places beds of diatomite.

Use and management.—This phase is used for natural range pasture and is of about average suitability. Grazing control is more essential than on Baker silt loam because of steeper slopes, greater surface runoff, and greater susceptibility to erosion. A few acres having slopes up to 14 percent are cultivated. This soil should be tilled on the contour when cultivated and irrigated carefully to control soil erosion as much as possible. It should be kept in pasture or hay to the greatest extent possible.

The included soils occurring in Eagle Valley are largely irrigated, seeded to alfalfa or bluegrass, and used mostly for pasture. They provide excellent pasture.

Baker silt loam, eroded hilly phase (12–25% slopes) (Bc).—Moderately to severely eroded areas make up this phase. It differs from Baker silt loam in being steeper and more eroded and in having a surface soil shallower, stonier, more gravelly, and more variable in depth. More than 25 percent of the surface soil has been lost through erosion. Severe erosion is not common. Deep gullies are rare, but there are few shallow ones.

Use and management.—This phase is used primarily for grazing. Most of it has been overgrazed, and the range has been somewhat depleted. Strict grazing control is needed to prevent further damage to the range and erosion of the soil. The number of livestock on the range should be closely adjusted to a safe carrying capacity; grazing should be deferred in spring until the plants are ready; and rotational grazing is advisable. Reseeding of some areas may be necessary.

Baker silt loam, coarse-textured subsoil phase (0–7% slopes) (Bb).—This phase is more nearly a variant of Baker silt loam and differs from it principally in having a less compact and less clayey and more alkaline upper subsoil over fragmentary or weakly cemented hardpan. The soil has formed on nearly level or undulating slightly dissected terraces from old alluvium that is mostly of granitic origin but includes much material of basaltic, argillitic, and other origin. Because of smooth relief there has been little accelerated erosion. Surface drainage is medium, and underdrainage below the compact layer is very rapid. This phase has nearly stone-free surface soil, is permeable to roots and moisture, and has a good water-holding capacity. In some areas the soil contains excess soluble salts, or alkali, in the subsoil, but not enough to affect growth of crops. Some of this soil south of North Powder is apparently associated with the area irrigated by water from Hot Creek. Much of the water in this creek comes from Fisher Hot Springs and is strongly alkaline. The quantity of alkali in the soil is increasing because of the irrigation water used. The natural vegetation is chiefly big sagebrush and grass.

Profile description.—The surface soil, to a depth of about 6 inches, is light brownish-gray or grayish-brown friable silt loam or loam. It overlies light brownish-gray firm silt loam or loam. Both layers

are noncalcareous in all areas except the irrigated ones; in those they may effervesce slightly when dilute hydrochloric acid is applied. The organic content is low in both layers.

The upper subsoil between average depths of 12 and 20 inches is pale-brown rather compact heavy loam or gritty clay loam that breaks into nutlike aggregates fairly easy to crumble. This material is strongly alkaline and calcareous and contains black alkali [1] or organic stains in places. The subsoil between average depths of 20 to 30 inches is brown compact clay loam that breaks with a vertical cleavage into nutlike aggregates difficult to crumble. This material contains some imbedded gravel and is calcareous in places. It abruptly overlies pale-brown or yellowish-brown strongly alkaline limy fragmentary or weakly cemented hardpan that is rather difficult to penetrate with a crowbar.

Depths to the hardpan range from 20 to 50 inches or more, and there is a corresponding variation in the thickness of the layers above. The hardpan layer, 1 to 2 feet thick, is underlain to a depth of 8 feet or more by beds of calcareous rather compact gravel, sand, cobblestones, and loamy materials. These materials are less calcareous with increase in depth.

Use and management.—About 80 percent of this phase is cultivated under irrigation. Alfalfa, the main crop, produces about 2 tons an acre annually in two cuttings. Small grains are also grown under irrigation. Uncleared areas are used for natural range grazing. The use of strongly alkaline irrigation water, if continued, may eventually greatly lower productivity.

BALDOCK SERIES

Soils of the Baldock series are formed on imperfectly or somewhat poorly drained alluvial fans, stream bottom lands, and old lake basins. They cover a large total area and occur in a semiarid climate where the mean annual precipitation is 9 to 13 inches, including the moderate snowfall. Surface drainage is slow to very slow, and underdrainage is restricted by the fairly high water table, though the soils are permeable. Nonetheless, drainage generally is adequate for grains and pasture crops. The level or very gently sloping topography is suggestive of old lake bottoms. The gravel substrata, however, indicate that the lower material is largely alluvial-fan or stream-deposited material. The surface soil is free from stones and nearly free from gravel. Much mica occurs in the lower subsoil. The Baldock profile shows no or only very slight textural and structural differentiation between layers. Mineralogically, the parent material is of mixed origin and comes largely from basalt, argillite, granite, related rock, and soils formed thereon.

Baldock silt loam (0–2% slopes) (Bm).—Associated with other Baldock soils and those of the Gooch series, this soil resembles Gooch silt loam but lacks the slowly to very slowly permeable clayey subsoil and contains less alkali and soluble salts. Although much of the soil contains a small quantity of salts or is affected by alkali, there is not enough to interfere seriously with the production of alfalfa and

[1] See section on Soluble Salts and Alkali, in Soils, p. 140.

grains, but too much for most fruits and garden crops. The natural vegetation is largely grass, but there is some sagebrush, greasewood, rabbitbrush, and flowering plants. Saltgrass, wild barley, tall ryegrass, and cheatgrass are dominant among the grasses.

Profile description.—The surface layer, to an average depth of 5 inches, is gray or light brownish-gray heavy silt loam, root-bound in virgin areas and of slightly platy structure. The lower part of the surface soil, between average depths of 5 and 13 inches, is similarly colored friable heavy silt loam that breaks into small easily crumbled aggregates. The surface layers are calcareous and strongly to moderately alkaline. The organic content is moderate, and there are many fine roots. When moist, the color of the soil ranges from very dark gray to dark grayish brown.

The upper subsoil, extending from about 13 to 34 inches, is gray, light brownish-gray, or grayish-brown friable or slightly compact heavy silt loam that breaks into subangular easily crumbled aggregates. There are many fine root channels, a few yellowish-brown mottles, and in places faint variegations of grayish brown and yellowish brown. The material is moderately to strongly alkaline and slightly limy. The content of lime decreases with increasing depth. When moist, this layer is very dark gray or dark grayish brown.

The lower subsoil, between average depths of 34 and 54 inches, is light-gray or light brownish-gray silt loam or loam containing some spots and streaks of light yellowish brown. The color ranges to light olive-gray in the lower part. When moist, the material is dark grayish brown or olive gray.

Stratified beds of light-gray, light olive-gray, or pale-olive noncalcareous gravel and sand lie below an average depth of 54 inches and in most places extend downward to a depth of 10 feet or more. The gravel is waterlogged much of the year. The depths to the very porous substrata range from 3 to 6 feet or more.

Included with this soil are several areas in which the lower subsoil is not typical. In places a 10-inch layer of nearly white volcanic ash lies at the depth of the lower subsoil. Buried dark-colored layers of old soil occur in the subsoil or substratum. Thin layers of fine sandy loam and a very few rounded pebbles are in the lower part of the subsoil in many places. Here and there the lower subsoil contains a 6-inch layer of light olive-gray or gray clay loam containing much imbedded gravel.

Use and management.—Over 60 percent of Baldock silt loam is cultivated under irrigation, and other areas are irrigated for wild hay. The rest is used for natural range pasture (pl. 1, *A*). The grazing capacity is greatly enhanced by natural subirrigation and by irrigating with floodwaters in the spring. Practically none of the soil is dry-farmed.

Owing to the nearly level relief, practically no erosion has occurred, but some material washed out in placer mining has been deposited on the soil. Drainage is the main problem. Slow internal drainage favors the accumulation of soluble salts in the soil and impairs its productiveness. This danger is especially great under the common system of irrigation by flooding, which allows the evaporation of much water at the surface.

Baldock loam (0–2% slopes) (Bk).—A fairly large total area is covered by this soil, which is associated with other Baldock soils and those of the Gooch series. The natural vegetation consists largely of grasses, including much saltgrass, and scattered rabbitbrush, big sagebrush, and greasewood.

Profile description.—To a depth of about 5 inches the surface soil is gray, light brownish-gray, or grayish-brown calcareous loam or very fine sandy loam. It is sod-bound in virgin areas and breaks into fine crumbs and single grains when cultivated. The moist soil ranges from very dark gray to dark grayish brown. The material is moderately alkaline in better drained areas and ranges to strongly or very strongly alkaline in small depressions. The organic-matter content is fair or moderate.

The lower part of the surface soil, between depths of 5 and 14 inches, is calcareous very friable loam or very fine sandy loam that breaks into small easily crumbled aggregates and is similar to the upper layer in color. Both layers contain a few pebbles in places but are free from stones.

The upper subsoil, between depths of about 14 and 34 inches, is gray, light brownish-gray, or grayish-brown calcareous friable loam, heavy loam, or very fine sandy loam that breaks into large subangular easily crumbled aggregates. It is mildly to strongly alkaline and in most places is less alkaline with increasing depth. The layer is very dark gray or dark grayish brown when moist.

The lower subsoil, between average depths of 34 and 48 inches, is light-gray, light brownish-gray, or light olive-gray slightly calcareous mildly to strongly alkaline loam that contains thin layers of fine sand and a few pebbles in places. When moist, it is dark grayish brown or olive gray. In a few places a 10-inch layer of nearly white volcanic ash or dust is in the lower part.

Both subsoil layers are permeable, contain many fine roots, and are low in organic-matter content. They are underlain by stratified layers of light-gray, light olive-gray, or pale-olive noncalcareous gravelly sandy loam, sand, and gravel that extend downward to a depth of 10 feet or more in most places. The depth to the very porous gravelly substratum ranges from 3 to 6 feet or more. The substratum is waterlogged most of the year.

The soil varies somewhat. In places its subsoil contains a layer of clayey material. Buried dark-colored old surface-soil layers may be present in the subsoil or substratum. Variegations, specks, or mottlings of yellowish brown and grayish brown are in the subsoil and substratum in places.

Use and management.—About 50 percent of Baldock loam is cultivated under irrigation, and the rest is used for natural range or saltgrass pasture. Most areas in natural pasture are sometimes irrigated with floodwater in the early spring. The grazing capacity is much greater in areas naturally subirrigated. Wheat and alfalfa are the main crops. The maximum for wheat is over 40 bushels. Alfalfa produces higher yields than average if water for irrigation is available after July 1. Alfalfa is short-lived in places because the water table is high in spring. The most productive areas are southwest of Haines.

Wash from gold placer mines deposited on this soil has more than compensated for any erosion. The soil would be benefited by better drainage. It is alkaline and contains excess soluble salts—not enough to prevent the growth of small grains and alfalfa but too much for most fruits and garden crops. When the surface soil in depressions is dry, it sometimes has a trace of white efflorescence of soluble salts. The quantity of soluble salts or alkali is apparently increasing. This is now a productive soil, but it is on the borderline for injurious salt accumulation and needs to be protected from further accumulation by better drainage. Special pains should be taken to prevent standing surface water.

Baldock loam, gravelly subsoil phase (0–2% slopes) (Bl).—The gravelly substratum lies at a shallower depth, but otherwise this phase resembles Baldock loam. It occurs in narrow belts along intermittent streams where the surface drainage is slower and the water table is higher than in Baldock loam.

Profile description.—The surface soil is gray, light brownish-gray, or grayish-brown strongly to moderately alkaline calcareous loam. To a depth of 5 inches it has a slightly platy structure, and below this depth it breaks into subangular easily crumbled aggregates. The material is free from stones and gravel, moderate in organic-matter content, and very dark gray to dark grayish brown when moist.

The upper subsoil, extending from about 12 to 20 inches, is gray, light brownish-gray, or grayish-brown faintly variegated calcareous friable loam. This rests on stratified beds of light-gray, light olive-gray, or pale-olive rounded gravel and sand that extend to a depth of 10 feet or more in most places. The depth to the porous gravel or sand ranges from about 12 to 36 inches, and there is a somewhat corresponding variation in the thickness of the upper soil layers.

Use and management.—About 55 percent of this phase is cultivated under irrigation. The principal crops are wheat, barley, oats, and some alfalfa. The yields are slightly lower than on Baldock loam. Alfalfa is short-lived in many places because of the moderately high water table. Uncleared areas provide good salt-grass pasture. The soil in places receives some deposition from streams.

BALM SERIES

Soils of the Balm series are of fairly recent alluvial origin. In the upper part they consist of calcareous medium- or coarse-textured materials. The lower consists of loose very porous coarse-textured materials. The profile shows practically no differentiation of textural and structural layers. The soils occur in level or nearly level stream bottom lands. The annual precipitation is 9 to 12 inches. The alluvial parent material is derived largely from basalt, granite, greenstone, and related rocks and soils formed thereon. Drainage is poor. The soils are often inundated by spring floods, and low places are wet during summer. Internal drainage is restricted by the high water table, which commonly stands at a depth of 2 to 5 feet. The Balm soils in places contain more or less soluble salts or alkali. They differ from the Baldock soils mainly in having a browner surface soil and coarser textured more porous materials in the lower parts of the profile, and from Hershal soils in being calcareous.

Balm loam (0–2% slopes) (Bo).—In places this soil is cut up by old stream meanders. Underdrainage is restricted by the high water table. Smooth relief and the good grass cover allow little or no erosion. The natural vegetation is mostly grass, including some saltgrass, bluegrass, alkali-grass, orchard grass, and wild barley. A few greasewood and sagebrush shrubs grow in places, and some cottonwoods, willows, and aspens grow along the streams.

Profile description.—The surface soil to an average depth of 9 inches is grayish-brown calcareous mildly to strongly alkaline slightly hard loam or silt loam of weakly granular structure. It is dark grayish brown or very dark gray and friable when moist, moderate in organic content, and nearly free of cobblestones and gravel. In virgin areas the upper 4 or 5 inches is bound by saltgrass and other grass roots. The soil material between average depths of 9 and 18 inches is grayish-brown mildly to moderately alkaline calcareous micaceous loam containing few pebbles and a few yellowish-brown mottlings in places. It ranges from loam to sandy loam. The loam changes sharply to stratified beds of grayish-brown or brown loose sand, gravel, and small water-worn cobblestones. The gravelly material extends to a depth of 10 feet or more. In most places it is mildly alkaline and noncalcareous. Much mica is present. The depth to the loose gravel and sand ranges from about 10 to 36 inches.

The upper part of the profile is permeable, and the lower part is very porous. The water-holding capacity is rather low; but because the water table stands at a depth of about 3 feet, this capacity is not so important except where the soil is drained. The soil in places is more or less saline. Here and there it is noncalcareous.

Because of their small total extent (about one-half square mile), small areas in Eagle Valley having a fine sandy loam, very fine sandy loam, or sandy loam surface soil about 8 inches thick are included with this soil. The soils in these areas contain few pebbles and rounded cobblestones. Their upper layers overlie calcareous single-grained fine sandy loam or sandy loam containing interbedded layers of fine sand and very fine sandy loam, much mica, and a trace of yellowish-brown mottling. At a depth of about 2 feet these materials are underlain by grayish-brown or brown loose loamy fine sand containing interbedded layers of sand and gravel. The included areas have about the same agricultural value as the normal soil.

Use and management.—Balm loam is used mostly for native pasture and is well suited to that use. Most of it is irrigated and nearly all of it is naturally subirrigated. Small better drained areas are cultivated, mostly for grain. The soil is too porous to be especially productive.

Balm gravelly sandy loam (0–2% slopes) (Bn).—Except for its coarser textured surface soil, which is gravelly, sandy, and in places cobbly, this type resembles the closely associated Balm loam in most respects. It occurs on level or nearly level stream bottom lands in places cut up by old stream channels, and the microrelief is therefore somewhat uneven or hummocky. Surface drainage is slow, and underdrainage is restricted by the high water table that generally supplies much water for subirrigation. The soil is rapidly or very rapidly permeable, very porous, and low in water-holding capacity.

Many roots penetrate to a depth of 4 feet or more. The native vegetation is grass, including much saltgrass, and a few greasewood and sagebrush shrubs. Along the stream channels there are a few trees.

Profile description.—The surface soil, rather low or moderate in content of organic matter, is grayish-brown calcareous mildly to strongly alkaline gravelly sandy loam to an average depth of 8 inches. It is mainly single-grained. Many pebbles and cobblestones are scattered on and in the surface soil. Rather brown gravelly areas much like riverwash are fairly common. Under native vegetation the upper 4 inches of this layer is root-bound.

The soil material between average depths of 8 and 18 inches is grayish-brown or brown mildly calcareous mildly to strongly alkaline gravelly sandy loam containing many rounded cobblestones. Yellowish-brown mottlings are common. This material rests on stratified layers of grayish-brown or brown loose gravel, sand, and water-worn cobblestones that extend to a depth of 10 feet of more. In places this lower lying material is gray and more or less mottled with yellowish brown. It is noncalcareous or only very mildly calcareous. The depth to the loose gravel and sand ranges from about 8 to 36 inches.

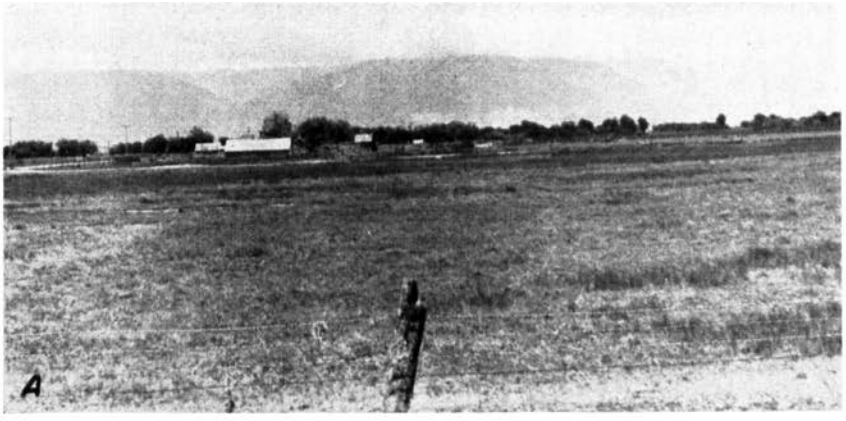
Much mica occurs in the entire profile. The content of pebbles and cobblestones is variable. In some places the surface soil is nearly free of cobblestones, and in other areas it is nearly covered with them. Here and there the soil is noncalcareous. In places the soil contains some salts or alkali. Some of the areas near North Powder have a grayer surface soil and a higher salt content than elsewhere. A thin layer of sandy recent sediment covers the surface in places.

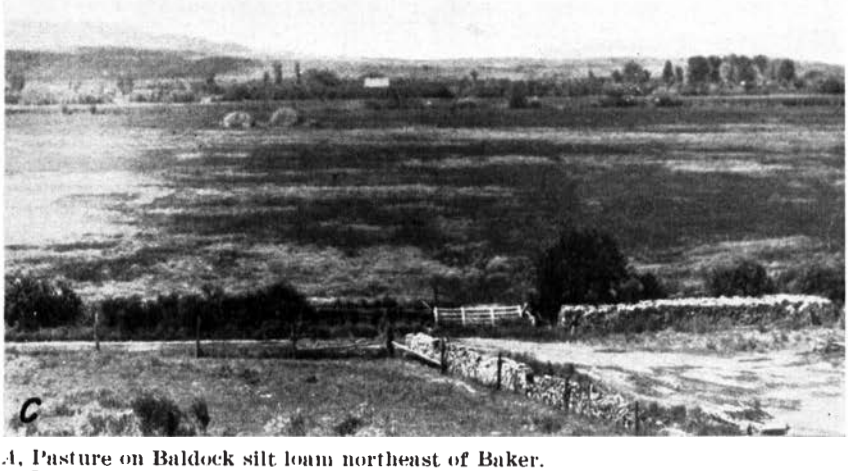
Use and management.—Nearly all of this type is used for native pasture, mostly under irrigation. Although it is rather porous and gravelly, it produces good pastures when irrigated. Most of it is naturally subirrigated. Small areas have been cultivated but most of them have been allowed to revert to pasture. Some of the areas near North Powder contain too much salt or alkali for most cultivated crops, and their grazing value is lower than elsewhere. There has been little erosion because it has been checked by the low relief and sod-bound surface soil.

BARNARD SERIES

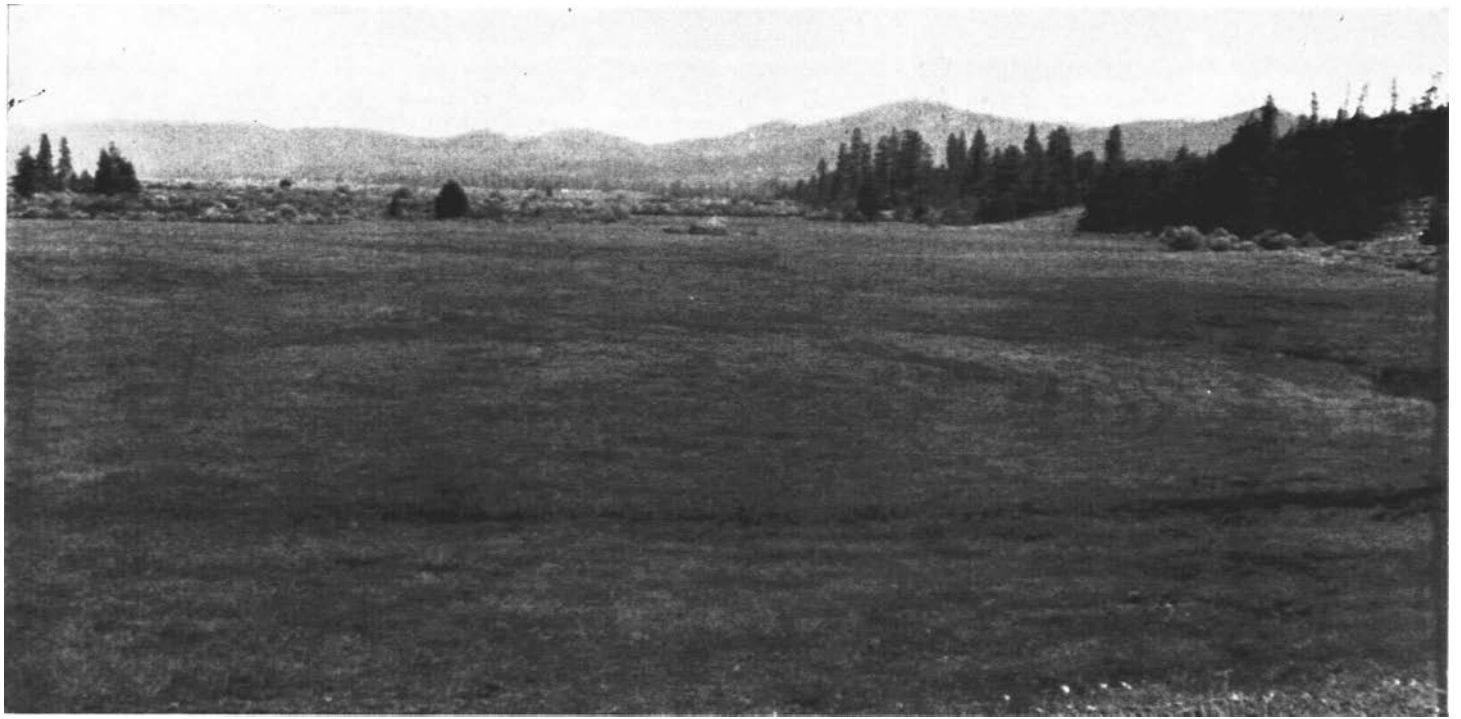
Soils of the Barnard series developed from stratified materials consisting of clay, semiconsolidated conglomerate, some basalt, tuff, diatomite, and other sediments under a cover of big sagebrush and grass and an annual precipitation of 9 to 12 inches, including some snow. They occur extensively on dissected high sloping benches in Eagle Valley and are productive when irrigated. Barnard soils are more permeable than the Virtue soils and differ from the Baker soils in being developed from semiconsolidated materials.

Barnard clay loam (2–12% slopes) (Bp).—This soil occupies old terraces and has a lime-cemented hardpan. The topography is representative of high youthfully dissected gently sloping benches that generally lie 100 to 200 feet above Powder River. The larger areas have a fairly smooth slope of 2 to 7 percent, but some areas are nearly level, and many have slopes between 7 and 12 percent. The areas break off in sharp escarpments to lower levels. Surface runoff is





A, Pasture on Baldock silt loam northeast of Baker.
B, Pasture on Baldock and Catherine soils north of Baker.
C, Pasture on Catherine loam beyond road; area is southeast of Wolf Creek School.



Meadow on Catherine silty clay loam and Catherine silty clay loam, overwash phase, about one-fourth mile southwest of Hershal in Sumpter Valley; mostly Hershal silt loam, gravelly subsoil phase, on brush-covered bottom land in middle distance; mainly McEwen loam on pine-covered terrace to right. Blue Mountains in distance.

medium to rapid. Internal drainage is somewhat restricted above the hardpan and very slow through the hardpan, but the soil is adequately drained for most crops.

Profile description.—Barnard clay loam shows strong differentiation of layers. The surface soil to a depth of 8 inches is grayish-brown or light brownish-gray slightly hard clay loam. The organic-matter content is moderate to moderately low, and the reaction is neutral or mildy alkaline. The material is nearly free of stones but contains a small quantity of gravel. It is dark grayish brown and friable when moist and breaks into medium and fine granules. This layer grades at depths of 8 to 14 inches into grayish-brown neutral or mildly alkaline clay loam that breaks into small irregular hard aggregates.

The upper subsoil, between depths of 14 and 20 inches, is brown mildly or moderately alkaline compact clay loam or gritty clay that breaks vertically into large irregular blocks, which can in turn be broken into distinct very hard fine nutlike aggregates. In places this layer is faintly calcareous. After a gradual transition this layer is replaced by calcareous compact brown to yellowish-brown clay loam or heavy loam that is variegated with brown and light yellowish brown and breaks into angular hard nutlike aggregates. The lower part of the layer is light yellowish brown and very pale brown.

At an average depth of 28 inches there is an abrupt change to a light-gray or white lime-cemented hardpan marked with some light yellowish brown and very pale brown. This hardpan effervesces strongly, is strongly alkaline, is hard to penetrate with a crowbar, and is very slowly permeable or impermeable to moisture. Its average thickness is 24 inches. Under the hardpan is stratified weakly consolidated material consisting of layers of pale-brown clay, weakly cemented gravel, some basalt, water-laid tuff, and diatomite in places. The consolidated material is calcareous in the upper part and generally noncalcareous below 6 feet. It varies from place to place because the deposits are stratified.

A few rounded and subangular cobblestones and pebbles are on and in the surface soil, but not in sufficient quantity to interfere with cultivation. The subsoil has a moderate water-holding capacity, and the material above the caliche hardpan is slowly permeable to roots and moisture. The caliche hardpan is not alkaline enough to affect the productiveness of the soil.

Use and management.—Probably 65 percent of Barnard clay loam is under cultivation. Most areas below the irrigation ditch are cultivated, and those above are uncleared and used for natural range pasture. The percentage of cultivated land is unusually high because of an abundance of irrigation water.

The common crops of the region are grown, but about 50 percent of the cultivated land is used for alfalfa. Owing to damage by alfalfa wilt and alfalfa weevil, the acreage of alfalfa has been greatly reduced, and that of clover has been increased. Clover produces 200 to 300 pounds of seed an acre. Some areas are kept in semipermanent bluegrass pasture. Garden crops and apples are grown for home use and do well.

This soil should be cultivated on the contour and requires very careful irrigation to prevent excessive runoff and to avoid erosion. It is moderately deep and sheet erosion could reduce productivity.

Barnard clay loam, eroded phase (2–12% slopes) (BR).—This phase consists of eroded areas of Barnard clay loam and it is similar to that soil except for having a shallower surface soil caused by greater erosion. It is used only for range pasture and is somewhat below average for that purpose. The heavy grazing it has received in the past should be somewhat reduced to forestall further damage from erosion.

Barnard clay loam, hilly phase (12–25% slopes) (Bs).—The soil resembles Barnard clay loam but has steeper relief and a somewhat more variable subsoil because of outcrops of stratified material on the hillsides. The lime-hardpan layer in the subsoil is not so thick nor so consistently developed as in Barnard clay loam. Relief is strongly rolling to hilly, and many areas occur in ravines below high benches. The slopes interfere considerably with the use of farm machinery and the distribution of irrigation water and make the soil more susceptible to erosion.

Use and management.—About 50 percent of this soil is under irrigation. It is used principally for hay and pasture; wheat and oats are used primarily as nurse crops. Alfalfa is grown on the less steep slopes. The stronger slopes are used generally for bluegrass pasture; some of the irrigated slopes used are as steep as 40 percent. The steeper slopes wash easily and have lost some of their surface soil. An acre of irrigated pasture on this soil will sustain one cow during the summer. The uncleared areas furnish rather scant pasture in spring and early summer.

Where irrigated, this soil must be handled very carefully to prevent waste water from flowing down the slopes and forming gullies. A sprinkler system of irrigation would spread the water better on steep slopes, but costs may be prohibitive for the crops currently grown.

Barnard clay loam, eroded hilly phase (12–25% slopes) (BQ).—Hilly moderately or severely sheet-eroded or gullied areas with dominant slopes exceeding 12 percent are occupied by this soil. The surface soil is shallower and the lime hardpan in the subsoil is less consistently developed and generally thinner than in Barnard clay loam, but other internal characteristics are similar. The soil profile is more variable because a variety of stratified layers crop out on hillsides. In most places more than 25 percent of the original surface soil has been lost through erosion, and some areas are gullied. This soil occurs on slopes and breaks below high benches. A total area of somewhat less than a square mile is included in which dominant slopes exceed 25 percent.

Use and management.—This phase is used for range pasture and furnishes rather scant grazing. Grazing must be carefully controlled to prevent further soil erosion and depletion of the range. The number of livestock should be closely adjusted to the carrying capacity of the soil. Grazing should be deferred in the spring until plants are ready, and rotational grazing is advisable. Some areas may need to be reseeded.

BROWNLEE SERIES

Soils of the Brownlee series are well-drained, micaceous, and rather shallow. They developed from residuum of albite granite under a grass and big sagebrush cover and an annual precipitation of 15 to

21 inches, including considerable snow. Relief of most areas is rolling or gently rolling, but the series includes many hilly and some broken and undulating soil areas. In general Brownlee soils are darker at higher elevations and lighter at the lower. They are moderately or somewhat slowly permeable and have moderate differentiation of textural and structural layers in the profile. The entire profile is noncalcareous. The soils of this series are associated with the Moscow, Glasgow, Lookout, Virtue, Ruckles, Keating, and other soils. They are distinguished from the Moscow soils by their darker surface soil, and from the Glasgow and Keating soils by their granitic parent material.

Brownlee loam (2–25% slopes) (Bт).—This is an extensive dark-colored soil formed in the uplands. It occupies domelike areas more or less dissected by streams and is associated with the timber-covered Moscow soils and the sagebrush- and grass-covered Glasgow, Lookout, and other soils. A few areas have slopes steeper than 25 percent. Surface runoff ranges from medium to very rapid; internal drainage is moderate to somewhat slow but adequate. Except where it is shallow over bedrock, the soil has good water-holding capacity. The subsoil is moderately or somewhat slowly permeable.

Although mainly grass and big sagebrush, the natural vegetation includes some scattered rabbitbrush, bitterbrush, mountain-mahogany, and other shrubs. A few scattered ponderosa pines grow on this soil near Sparta. Cheatgrass is the most common grass, but a considerable part of the grass cover consists of big bunchgrass, Sandberg bluegrass, needle-and-thread grass, Indian ricegrass, and such better forage grasses.

Profile description.—The surface soil—ranging from dark grayish brown to grayish brown and from a mellow loam to a heavy gritty loam—is very dark brown when moist, friable, granular, and neutral or slightly acid. At a depth of about 4 inches, this layer passes into slightly lighter colored somewhat granular loam or clay loam. The combined thickness of the two layers ranges from 8 to 20 inches.

The upper subsoil, between average depths of 12 and 24 inches, is brown compact clay loam containing a trace of mica and some rotten granite. It breaks along irregular vertical cleavage planes into hard rough subangular nutlike aggregates or medium granules and is neutral or slightly acid. It is dark brown when moist. From 24 to 36 inches, it is a brown compact clay loam containing much partly weathered granite. This material breaks into irregular nutlike aggregates or medium granules that crumble fairly easily. It ranges from neutral to mildly alkaline and is noncalcareous.

Below 36 inches brown or yellowish-brown loam or coarse clay loam occurs as interstitial material between partly weathered fragments of granite. This material is difficult to penetrate with a bar because it contains so much rock. The weathered rock is albite granite, gray to yellow variegated with yellowish brown. Below 48 inches the material is yellow and gray granite containing much nearly white albite.

Some variation in profile characteristics occurs. In places the subsoil is a heavy clay loam or clay somewhat less permeable than elsewhere. The depth to bedrock ranges from 15 to 50 inches. A few

stone are scattered over the surface in places, and bedrock outcrops here and there, but most of the soil is not excessively stony.

Use and management.—The greater part of Brownlee loam is used for grazing, and it is well suited to that use if care is exercised to prevent overgrazing. Heavy grazing has more or less depleted the range and allowed some loss of topsoil through erosion. Erosion lowers the productivity and should be minimized. Productivity of the range will be increased if spring grazing is deferred until plants have sufficient growth and is stopped before the stubble is grazed too short. A small acreage of this soil with slopes of less than 12 percent is cultivated, mostly under irrigation, to alfalfa and wheat.

Brownlee loam, eroded phase (2–25% slopes) (Bu).—Moderately eroded, severely eroded, and gullied areas were included with this soil. It is essentially similiar to Brownlee loam, but its surface soil is thinner and more irregular in depth. In small severely eroded areas the surface soil is very thin, the subsoil is exposed in places, and there are a few shallow gullies. This phase is more extensive than Brownlee loam.

Use and management.—About 4 percent of this phase is cultivated, mainly to wheat and alfalfa under irrigation. Most of it is used for range pasture of average grazing value. The range land should be protected from overgrazing, and cultivated areas require special care to prevent erosion. The soil erodes easily, and being rather shallow, is seriously injured by even moderate erosion. Deferred grazing, rotational grazing, and reseeding of some areas would increase the productivity of the grass cover and tend to check further erosion.

Brownlee loam, eroded steep phase (20–35% slopes) (Bw).—This phase consists of moderately eroded, severely eroded, and gullied areas on steep relief. It occurs principally along V-shaped ravines, and the total area is small. In places the greater part of the surface soil has been lost by erosion, here and there the subsoil is exposed, and in some areas a few shallow gullies have formed. Surface runoff is more rapid than on Brownlee loam. The surface soil is thinner, and the subsoil is thinner, lighter textured, and shallower to bedrock.

Use and management.—This phase is used for range pasture but the grazing value is rather low. Grazing should be strictly controlled to prevent further damage to the range and to check erosion. In spring, grazing should be deferred until the grass has made sufficient growth, and rotational grazing is highly desirable. The plants should not be grazed too short. Some areas should be reseeded.

Brownlee loam, shallow phase (2–25% slopes) (Bx).—This phase is shallower to the granite bedrock and somewhat more eroded than Brownlee loam. Granite bedrock is close to the surface and some stones are scattered over the soil. The soil, however, is not especially stony.

Profile description.—The surface soil is moderately dark grayish-brown friable loam to a depth of about 6 inches. The lower part is slightly browner. The upper subsoil, occurring between average depths of 6 and 14 inches, is brown rather compact clay loam or heavy loam containing much rotten granite. Underlying this is variegated brown, very pale-brown, yellowish-brown, and gray decomposed

granite in which some brown coarse loam occurs as interstitial material. Between depths of 40 and 60 inches is mixed yellowish-brown, very pale-brown, brown, and nearly white disintegrated albite granite containing much hard undecomposed rock. The entire profile is neutral or slightly acid. The soil material above bedrock is moderately permeable.

Use and management.—This phase is not cultivated and is used mostly for range grazing. On some strongly sloping areas heavy grazing has caused moderate sheet erosion, and shallow gullies have formed in places.

Brownlee loam, eroded shallow phase (2–25% slopes) (Bv).—This moderately or severely eroded soil is shallow to bedrock. In most areas more than 25 percent of the original topsoil has been lost. The subsoil is exposed in places and a few shallow gullies have formed.

Use and management.—This phase is used in much the same way as Brownlee loam, shallow phase, but its thin surface soil tends to increase runoff and lowers productivity. The number of livestock should be carefully adjusted to the grazing capacity of the range, and the grass should not be grazed too early in spring nor too short.

BULGER SERIES

The soil of the Bulger series developed on smooth undulating or gently sloping well-drained old alluvial fans and terraces under a cover of grasses, big sagebrush, and many flowering plants. It is derived from old alluvium, mainly of granite and quartzite origin. The annual precipitation is 13 to 15 inches. Possibly a part of the upper profile is influenced somewhat by loess. The Bulger soil differs from Hutchinson soils chiefly in having a darker surface soil, a less compact upper subsoil, and a dense, or hardpan, lower subsoil, and from Virtue soils in having darker surface soil and a hardpan that is only faintly calcareous.

Bulger silt loam (0–7% slopes) (Bz).—This is a slightly dark-colored soil with a brown noncalcareous dense hardpan. The soil has fairly good water-holding capacity. Surface runoff is low to medium, and underdrainage is generally adequate, although the hardpan is nearly impermeable to roots and moisture. The soil is free of salts and alkali.

Profile description.—The surface soil is grayish-brown to slightly dark-gray or dark grayish-brown friable silt loam to an average depth of 6 inches. It has a fair to good organic-matter content, and is free of stones or gravel. When moist, it is dark grayish brown or very dark brown. The surface layer is underlain by grayish-brown friable silt loam. This material is dark grayish brown when moist, separates with a faint vertical breakage, and crumbles easily. The two layers just described are slightly acid or neutral.

At a depth of about 12 inches there is a gradual transition to a brown heavy silt loam that breaks along vertical planes into large masses easily crumbled into hard fine nutlike aggregates. The material of this layer is neutral in reaction, dark grayish brown, and friable when moist. The subsoil from 18 to 36 inches is a compact clay loam or clay with an irregular prismatic structure and neutral reaction. This

material is yellowish brown if crushed when dry and dark brown when moist. It is difficult to penetrate and breaks into very hard fine nutlike aggregates. There are many fine holes or old root channels. This layer grades into light yellowish-brown hard fine nutlike heavy gritty loam or clay loam of neutral or mildly alkaline reaction.

A noncalcareous dense indurated brown or slightly reddish brown hardpan streaked with white siliceous material occurs at an average depth of 48 inches. This hardpan, in most places 2 to 4 feet thick, is very difficult to penetrate with a crowbar or rock drill. Below it is brown or slightly yellowish-brown noncalcareous irregularly stratified coarse alluvial deposits of granitic and quartzitic origin that are mildly calcareous in places.

Use and management.—About 75 percent of Bulger silt loam is irrigated and cultivated. About half of the cultivated area is used for alfalfa. Wheat is grown under irrigation on about a fourth of the cultivated area. Oats, barley, and rye are the other main crops; they produce yields about average for the region. There has been very little erosion on this soil because relief is smooth. The uncultivated areas are used mainly for range grazing.

CATHERINE SERIES

Soils of the Catherine series are similar to Wingville soils but are not calcareous in any part of their profile. They formed on smooth, level, or nearly level stream bottom lands, alluvial fans, and old lake bottoms under imperfect or poor drainage. The native cover was grass, shrubs, and a few trees. The annual precipitation includes considerable snow and ranges from 11 to 25 inches. The soils have no or only very slight differentiation of textural layers but may be more or less stratified. The larger and more typical areas are in Sumpter and Bowen Valleys, but some occur in Baker (pl. 1, *B*), Eagle, and Lower Powder Valleys. Large areas formerly occupied by Catherine soils have been converted into placer diggings by gold miners.

Catherine loam (0–2% slopes) (Ca).—This dark to very dark soil is one of the most productive soils in the area. The parent material may be influenced by loessal or loesslike deposits but is mostly alluvium derived chiefly from granite, basalt, argillite, related rocks, and soils formed thereon. The soil developed under a natural vegetation of grass and some sagebrush. The annual precipitation is 14 to 16 inches. Surface runoff is slow but adequate for general farm crops. The subsoil is permeable and high in water-holding capacity. The soil is free of salts and alkali, and the water table is seldom high enough to waterlog it.

Profile description.—To a depth of about 6 inches the surface soil is dark-gray very friable loam. This layer is root-bound in virgin areas and black when moist. The lower part of the surface soil at 6 to 20 inches is a heavy loam that breaks into coarse granular aggregates, and it is similar to or slightly lighter than the upper surface soil in color. Both layers of surface soil are free of stones and gravel and high in organic content.

The part of the subsoil between average depths of 20 and 50 inches is gray, light-gray, or grayish-brown loam that breaks into irregular easily crumbled masses. There are some fine rust-brown

and grayish-brown variegations. The surface soil and subsoil are generally noncalcareous and vary from slightly acid to mildly alkaline.

Between depths of 50 and 72 inches the material is similar to the above layer but the texture is variable. Layers of clay loam, loam, or fine sand are present in places. Below a depth of 6 feet or more there are layers of gravelly loam, sand, small cobblestones, and finer sediments. The depth to the gravelly substratum, however, ranges from 3 to 8 feet or more. This gravelly layer is generally over 5 feet thick but it may be absent in places.

The soil in an area of about 350 acres southwest of Wolf Creek School differs from the typical soil in being shallower over the gravelly substratum. In this area gravelly material is at a depth of 12 to 36 inches instead of below 36 inches as in most other areas.

Use and management.—Most of Catherine loam is under cultivation. It is productive when adequately irrigated but occurs where water for irrigation is relatively scarce. Wheat and alfalfa are the important crops. Federation wheat is grown under irrigation; Baart wheat, under dry-farm practices. Many areas are planted to mixed bluegrass, timothy, clover, and other grasses (pl. 1, *C*). They are usually irrigated with floodwater in spring if it is available, and have some subirrigation. The crop yields on areas shallow to gravel are slightly lower than elsewhere. Owing to the nearly level relief, erosion has been unimportant. Drainage of the soil has been improved by ditching of irrigated areas.

Catherine silt loam (0–2%) (CB).—This dark soil is derived from medium-textured alluvium or lake-laid materials of mixed origin, but principally basaltic, granitic, or argillitic. Surface drainage is slow, and the substratum is generally waterlogged by a medium or high water table. The water-holding capacity is high, and the soil is permeable to water and roots. The soil differs from Wingville silt loam mainly in being noncalcareous and in containing no salts or alkali.

Profile description.—The surface soil is dark-gray or very dark-gray granular silt loam. The material is black or very dark gray when moist and contains a fairly large quantity of organic matter.

The subsoil, between depths of about 18 and 40 inches, is gray, light brownish-gray, or grayish-brown firm silt loam or clay loam. It contains faint light yellowish-brown mottlings, crumbles easily, and is dark grayish brown or very dark gray and friable when moist. The material between depths of about 40 and 60 inches is somewhat similar but is a little more mottled and contains some pebbles in many places. It rests on beds of grayish-brown, gray, or light brownish-gray loose gravel, cobblestones, sand, and finer sediments.

There is some variation in this soil, and areas of other soils are included in mapping. Stratified layers of somewhat different texture may be present in the subsoil. In Sumpter Valley the soil is slightly acid or neutral and noncalcareous throughout. In Baker and Lower Powder Valleys, however, it is neutral or mildly alkaline and noncalcareous in most places. The lime content varies considerably within short distances, however, and in places there may be a calcareous layer. The surface soil is free from stones and gravel, and the depth to the gravelly and sandy substrata ranges from 4 to 6 feet.

In Sumpter Valley the gravelly substrata are gold-bearing and extend to a depth of 25 to 35 feet, where they rest on finer sediments.

Included areas in Sumpter Valley totaling about one-third of a square mile have the gravelly substrata closer to the surface than typical. These areas lie near stream channels, are flooded during spring thaws, and are rather poorly drained. They have a dark-gray or dark grayish-brown friable silt loam surface soil about 12 inches thick and in many places contain some pebbles. The surface soil grades into a subsoil of gray, light brownish-gray, or grayish-brown friable silt loam or loam containing some gravel. The subsoil overlies beds of loose gravel, sand, cobblestones, and finer sediments at depths of 12 to 36 inches. These areas are noncalcareous, slightly acid or neutral, contain much mica, and are rapidly permeable.

Also included is about 250 acres of a slightly different soil in Eagle Valley where the annual precipitation is lower, or 9 to 11 inches, including little snowfall. This included soil lies on smooth nearly level high stream bottom lands or low terraces where natural drainage is somewhat better than typical. Surface drainage is restricted but is generally adequate for grain and hay crops. Owing to the better natural drainage, this soil is somewhat browner throughout than the typical soil. Its surface soil consists of dark-gray to dark grayish-brown friable medium-granular silt loam high in organic matter. This dark surface soil is 10 to 20 inches thick and black or very dark brown when moist. It grades into a grayish-brown friable medium-granular, or faintly nutlike, silt loam or loam faintly mottled with yellowish brown. The substrata, beginning below a depth of about 5 feet, consist of stratified grayish-brown loose gravelly sandy loam, gravel, sand, and cobblestones.

This included soil is permeable and in most places noncalcareous and mildly alkaline to neutral. It does not contain excess soluble salts. The alluvial material is of mixed origin, principally basaltic, argillitic, and granitic.

A slightly different soil covering about 50 acres in Sumpter Valley is included. It has a slowly permeable heavy-textured layer in the subsoil, and though poorly drained, does not contain excess soluble salts.

Use and management.—In Sumpter Valley much of Catherine silt loam is used for hay and pasture, but a considerable acreage has been destroyed by placer diggings. Oats are grown, but the season is too short for wheat. In Baker Valley, alfalfa, wheat, barley, and oats are grown. The included soil in Eagle Valley is used to great extent for corn because of the longer and warmer growing season. Red clover produces 5 bushels of seed an acre the second cutting. Because of the alfalfa weevil, more clover than alfalfa is now grown on this included soil.

Catherine silty clay loam (0–2% slopes) (Cc).—Except for its heavier texture this soil resembles Catherine silt loam. It also resembles Wingville silty clay loam but is noncalcareous and free from excess soluble salts. It is derived from somewhat clayey alluvium or lake-laid materials of mixed origin, but principally basaltic, granitic, or argillitic. Some areas have a slightly hummocky microrelief. Surface drainage is slow but generally adequate where the soil is irrigated and drained. The gravelly substrata are usually waterlogged in the

early spring, but the water table recedes during summer. The moderate or high water table provides some subirrigation. The soil is free of alkali, except where it borders soils containing alkali. It contains much mica throughout, and its surface soil is free from stones or gravel.

Profile description.—The surface soil is dark-gray or gray silty clay loam with a granular or slightly platy structure to a depth of 6 inches. Below this and continuing to a depth of 18 inches is similarly colored granular silty clay loam. These surface layers are black or very dark gray when moist and their combined thickness ranges from 12 to 30 inches. In virgin areas the upper part is root-bound and the lower part contains many roots. The organic-matter content is apparently high.

The upper subsoil, between average depths of 18 and 36 inches, is gray, light brownish-gray, or grayish-brown firm silty clay loam or clay loam that breaks with very faint vertical cleavage into large angular easily crumbled aggregates. It is faintly mottled with yellowish brown, contains many fine roots and channels, and is dark gray, very dark gray, or dark grayish brown when moist. The lower subsoil, occurring between depths of 36 and 60 inches, is in most places a similarly colored friable silty clay loam or clay loam that contains some pebbles and some yellowish-brown mottlings in the lower part. Thin layers of fine sand or a 10-inch layer of nearly white volcanic ash are at this depth in a few places. The lower subsoil rests on beds of grayish-brown or gray loose gravel, sand, cobblestones, and finer sediments that contain some yellowish-brown mottlings.

In Sumpter Valley the entire soil is noncalcareous and slightly acid or neutral, but in other areas it is mildly alkaline to neutral and noncalcareous in most places. Small patches with a calcareous layer in some part of the profile are included in mapping because of the great variation in lime content within short distances. The depth to the gravelly substrata ranges from 4 to 6 feet. The soil is permeable to water, air, and plant roots and has a high water-holding capacity.

Included with this soil is about 145 acres in Sumpter Valley slightly different because of its somewhat heavier textured more slowly permeable layer. This included soil is poorly drained but does not contain excess soluble salts.

Use and management.—Owing to the short growing season, the Catherine silty clay loam in Sumpter Valley is used mostly for hay and pasture. The meadows—largely of bluegrass, other grasses, and some alsike clover—produce an average of 1¾ tons an acre when cut for hay (pl. 2). Some oats are grown under irrigation. The climate in Sumpter Valley is especially suitable for oats. Large areas of the soil in Sumpter Valley have been destroyed by placer diggings, and other areas are covered with wash from placer mines. The areas covered with wash are mapped as the overwash phase of Catherine silty clay loam where of sufficient extent.

About 80 percent of this soil in Baker Valley is cultivated under irrigation and is very productive. The crops grown and the yields obtained are about the same as on Wingville silty clay loam.

Catherine silty clay loam, overwash phase (0–2% slopes) (Ce).—This phase includes areas where a layer of light-colored silty material overlies other soils. Typically these soils were dark-colored Cather-

ine silty clay loam, but in some places they were Wingville, Baldock, Powder, or other soils. The silty overwash is mainly from gold-placer mines. This soil occurs in level or nearly level bottom lands or basinlike areas covered with shallow water late in winter and early in spring. Surface drainage is very slow. Internal drainage is restricted by the waterlogged substratum, but the soil is moderately to slowly permeable. The native vegetation is mostly grass, including in places some saltgrass and a few scattered rabbitbrush and other shrubs. A few willows and haws grow along the stream channels.

Profile description.—The present surface soil is light brownish-gray smooth silty clay loam or silt loam mottled with light yellowish-brown, gray, and grayish-brown. It ranges from 4 to 36 inches in thickness but is generally about 12 inches thick. This material is distinctly laminated, contains a high percentage of silt, and has a low organic-matter content. It is grayish-brown mottled with yellowish-brown when moist.

Abruptly underlying the material just described is a 10- to 18-inch layer of dark-gray or gray firm silty clay loam that breaks into large clods. There are many fine channels. This dark layer was the surface soil before it was covered with the silty wash. It contains some fine light yellowish-brown mottlings and is very dark gray when moist. Between 26 and 44 inches the material consists of firm gray clay loam somewhat mottled with light yellowish brown. Between 44 and 60 inches the material is gray clay loam in most places but includes layers of loam, silt loam, and fine sandy loam and in places contains imbedded pebbles in the lower part. It rests on beds of gray or grayish-brown loose sand, gravel, small cobblestones, and finer sediments.

Typically, this phase is noncalcareous throughout and slightly acid to mildly alkaline. It contains considerable mica. The pebbles are from granite, argillite, quartzite, basalt, breccia, and other rocks. Thin layers of nearly white volcanic ash or gray clay occur in the lower subsoil in places.

Included with this phase are several areas near stream channels in Sumpter and Bowen Valleys that differ in being shallower to the beds of loose gravel, sand, and cobblestones. In these areas the depth to stony material ranges from 12 to 36 inches and averages 24 inches. There is a somewhat corresponding variation in thicknesses of the other layers. The light-colored overwash layer is 3 to 16 inches thick.

Also included is a total area of somewhat less than 2 square miles of slightly different soil. The lighter colored overwash material of this included soil overlies calcareous soils, principally Wingville silty clay loam but also some areas of Gooch and Baldock soils. In these areas most of the lighter colored surface overwash is noncalcareous and neutral or mildly alkaline. The underlying dark layer, or former surface soil, and the lighter-colored subsoil material beneath it are more or less calcareous and mildly to strongly alkaline. In places the included soil contains a slight quantity of excess soluble salts. The large area along Powder River north of Baker is mostly underlain by a soil similar to Powder silt loam.

Use and management.—In Sumpter (pl. 2) and Bowen Valleys this phase is used largely for native pasture. It is excellent for that use because the high water table supplies water for subirrigation and the soil is free of salts and alkali. The recent deposit of silty materials on

the surface apparently has had little detrimental effect on productivity. Wash from placer mines still is being deposited on much of the soil. Some of the areas would be difficult to drain, and drainage probably would decrease their grazing value by lowering the water table.

The included areas north of Baker and near Keating are used principally for native hay and pasture. The meadows contain much bluegrass, timothy, yellow sweetclover, and alsike clover, as well as native grasses, and produce about 1¼ tons an acre. About 3 acres of meadow will furnish pasture for one cow through the summer. About 20 percent of these areas is cultivated, mainly to small grains. Average yields produced are comparable with those on Catherine silty clay loam. The areas are now free, or nearly free, of alkali, but the content of soluble salts appears to be increasing and may in time impair productivity. Better surface drainage may be necessary in places to prevent the accumulation of salts, but the soil is difficult to drain because it lies in basinlike areas.

Catherine silty clay loam, gravelly subsoil phase (0–2% slopes) (Cd).—This phase resembles Catherine silty clay loam in most respects but the material above the loose gravel, sand, and cobblestones is thinner. The total area is very small.

The surface soil is dark-gray or gray crumbly silty clay loam or clay loam about 12 inches thick and contains some gravel in places. The subsoil is gray, light brownish-gray, or grayish-brown firm silty clay loam or clay loam containing some gravel in the lower part. It is underlain by beds of grayish-brown or gray loose gravel, sand, cobblestones, and finer sediments. The depth to the gravel averages 20 inches. The thickness of the dark surface soil is fairly uniform, whether the gravel is shallow or deep. In most places the entire soil is noncalcareous and slightly acid or neutral. It contains much mica.

Use and management of this soil are much the same as for Catherine silty clay loam, but yields are slightly lower.

CLOVER CREEK SERIES

The Clover Creek series is made up of well-drained soils developed in uplands from residuum of hard limestone bedrock. The soils formed under a cover of sagebrush, bitterbrush, mountain-mahogany, and grass in a semiarid climate where summers are fairly dry. The annual precipitation of 13 to 15 inches includes considerable snow. The average annual temperature is about 46° F. The soils are closely associated with those of the Keating series north of Lower Powder Valley, but the Keating have developed on residuum from greenstone, whereas these Clover Creek soils are derived from residuum from limestone lenses in the greenstone. Clover Creek soils are distinctive in character but of small extent, and only small areas are cultivated. The limestone substratum may be of importance in the manufacture of cement and other limestone products.

Clover Creek loam (2–12% slopes) (Cr).—Relief on this inextensive soil is gently rolling in most areas, but small bodies with steeper slopes are included. Surface runoff is medium; internal drainage is somewhat restricted, but the water-holding capacity is fairly good. The soil is slowly permeable to water, and easily penetrated by roots.

The natural vegetation is mostly sagebrush and grasses but includes considerable bitterbrush and mountain-mahogany.

Profile description.—To a depth of about 8 inches the soil is a dark grayish brown, slightly dark brown, or grayish-brown loam becoming very dark grayish brown or very dark brown when moist. The upper part is distinctly fine granular; the lower part breaks into medium granules. The material is neutral in reaction and noncalcareous.

The upper subsoil between 8 and 20 inches is brown or slightly dark brown compact somewhat tough clay loam or gritty clay. It cracks vertically into large blocks that break into very hard fine nutlike aggregates. The material is dark brown when moist. It is mildly alkaline and essentially noncalcareous, but in small areas does contain lime in the lower part. This layer grades into brown, mixed with some yellowish-brown, mildly calcareous gritty clay loam in which there are many limestone rock fragments. Weathered limestone underlies the soil at an average depth of 30 inches, but the range in depth is from 20 to 60 inches or more. The upper part of the limestone is fractured, and the cracks are filled with soil material. The underlying limestone bedrock is massive and very dark gray to dark gray.

Use and management.—Clover Creek loam is used principally for native pasture. Only small areas have been cleared and used for wheat and alfalfa. Under irrigation yields from both crops would be much higher. The soil has undergone some surface erosion, especially where overgrazing has depleted the grass cover.

Clover Creek stony loam (5–15% slopes) (Cg).—Many limestone fragments are scattered over the surface of this upland soil. It occurs in scattered small bodies, typically on rolling relief, and is closely associated with and resembles Keating stony loam but differs in containing lime in its lower subsoil and parent material. Some areas steeper than 15 percent are included. Steep areas of rock outcrop are common. A dendritic drainage system provides good drainage. The soil has a moderate water-holding capacity and is free of salts and alkali. Cheatgrass or downy chess is the principal vegetation, but other grasses are common. Many areas of this soil are distinguished from surrounding soils by their cover of mountain-mahogany.

Profile description.—The surface soil is dark grayish-brown to slightly dark brown very friable stony loam to a depth of about 8 inches. The upper part is of distinctly fine granular structure; the lower part breaks into medium granules. The material is neutral in reaction, noncalcareous, moderate in content of organic matter, and very dark grayish brown or very dark brown when moist.

The subsoil is brown or slightly dark-brown somewhat tough compact clay loam or gritty clay. It is noncalcareous and mildly alkaline in the upper part and calcareous, in places, below a depth of 20 inches. It is dark brown when moist. The upper part contains few rock fragments and breaks along vertical planes into coarse angular blocks and then into very hard fine nutlike aggregates. The lower part is brown to yellowish brown and contains some weathered limestone fragments.

At an average depth of 26 inches the subsoil grades into partly weathered limestone, and at a somewhat greater depth this weathered material grades into very dark-gray to dark-gray massive limestone bedrock of marblelike density (*1*). Fine roots penetrate some of the

rock crevices. The depth to bedrock ranges from 16 to 40 inches or more within short distances.

Use and management.—Most of Clover Creek stony loam is too shallow and stony to be cultivated, but there are some small areas of deep soils that can be cleared. It is used for range pasture and is well adapted to that use. Productivity of much of it has been considerably reduced by erosion following overgrazing. About 25 percent of the surface soil has been removed from much of the soil.

DURKEE SERIES

Soils of the Durkee series have a moderately or somewhat strongly developed subsoil and are formed of materials weathered from argillite bedrock. They are extensive in a belt beginning south of the old Flagstaff Mine and extending southeastward toward Lookout Mountain. The annual precipitation is 10 to 14 inches, including considerable snow. The drainage system, dendritic in pattern, provides medium to very rapid surface runoff, and the soils are somewhat slowly permeable. They are free of excessive accumulations of salts. The present vegetation is big sagebrush and grass, but early settlers report that grass was more prevalent before the area was settled.

Durkee stony clay loam (12–25% slopes) (Da).—This soil covers extensive mostly hilly or semimountainous areas where the relief is suggestive of dissected high domes and ridges. The soil receives an annual precipitation of 11 to 14 inches, including some snow. It is free of salts and alkali but has limited water-holding capacity because of its shallowness over rock. Fine roots go down to bedrock.

Profile description.—Durkee stony clay loam has moderate to slightly strong differentiation of profile layers. The surface soil, grayish-brown or light brownish-gray gravelly or stony clay loam to a depth of 14 inches, is somewhat granular and breaks into pea-size fragments. The upper part in virgin areas is root-bound. The organic-matter content is fair. The reaction is neutral or nearly so. Many angular argillite rock fragments are on and in this layer. As this phase is mapped, the texture of the surface soil ranges from stony clay loam to loam or silt loam. The material is very dark grayish brown or very dark gray when moist.

The upper subsoil, extending from a depth of about 14 to 20 inches, is grayish-brown, light brownish-gray, or brown mildly alkaline noncalcareous somewhat compact heavy clay loam or clay containing many rock fragments. It is rather hard to penetrate with a bar because of the many pebbles and stones. In many places the material breaks on the vertical cleavage planes into aggregates that are difficult to crumble. This layer is dark grayish brown when moist. From about 20 to 30 inches, the subsoil consists of many rock fragments imbedded in brown clay loam. The fine material of this layer ranges from brown in the upper part to pale brown or light brownish gray in the lower. It is moderately alkaline in reaction and is calcareous in the lower part in most places. The quantity of rock increases with depth.

Below 30 inches is partly decomposed argillite rock mixed with some pale-brown soil. This material grades at about 40 inches into nearly solid argillite bedrock that is dark gray or very dark gray, somewhat marbled, extremely hard, and resistant to weathering. Cracks in the bedrock contain brown weathered rock material.

Use and management.—Durkee stony clay loam is used for range grazing (pl. 3) and in comparison with other range land of the area, is average or slightly better than average. To obtain the most grazing, the number of livestock should be carefully adjusted to the carrying capacity. The greater part of this soil is too steep or too stony for cultivation.

Durkee stony clay loam, eroded phase (12–25% slopes) (DB).—This phase has been severely sheet-eroded or gullied. Much of the surface soil has been lost through sheet erosion, and shallow gullies are fairly common. In places the subsoil is exposed. The natural vegetation is similar to that on Durkee stony clay loam.

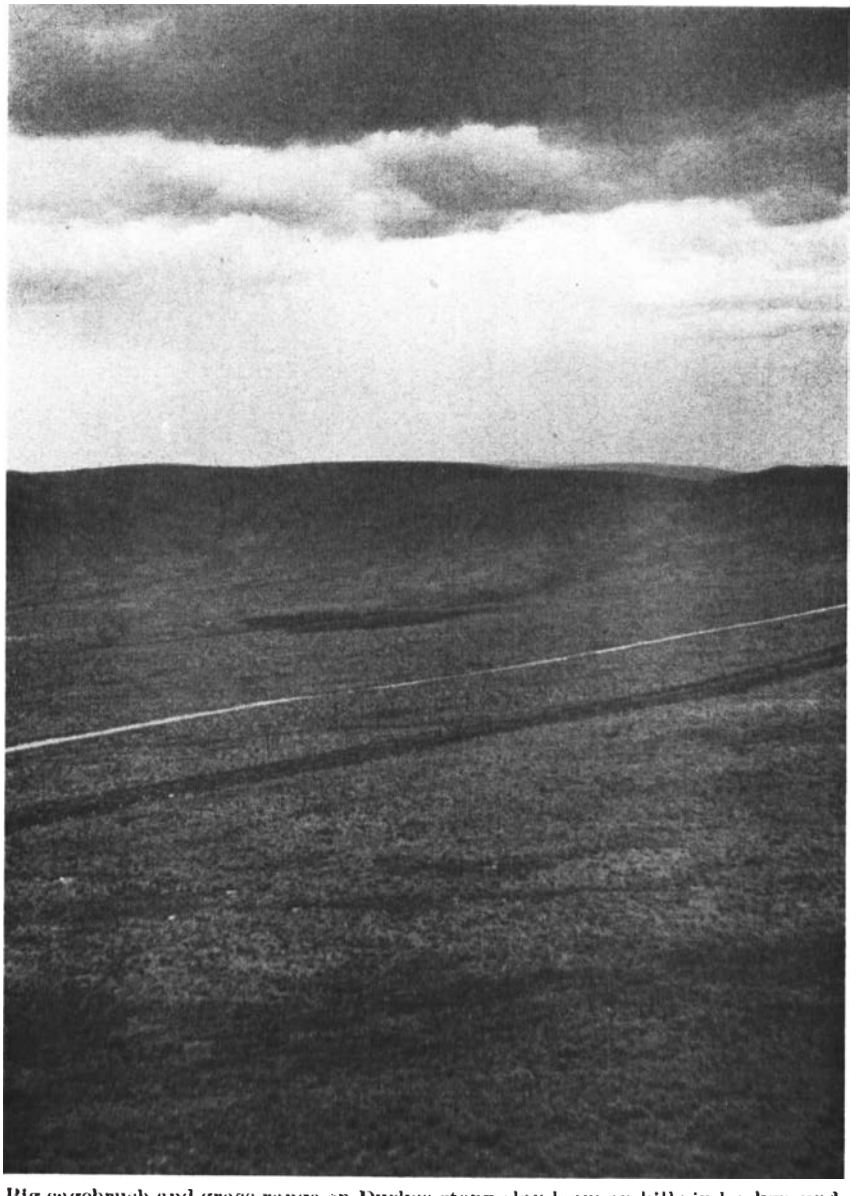
Use and management.—This phase is used almost entirely for range pasture. Its carrying capacity is somewhat less than that of the uneroded or only slightly eroded Durkee stony clay loam. Grazing should be carefully restricted to prevent further depletion of the range. Livestock should not be turned on the range in the spring before the grass has obtained sufficient growth, and the plants should not be grazed too short. An increase in the density and the growth of the grasses will tend to check or prevent further soil erosion.

Durkee stony clay loam, steep phase (25–45% slopes) (DD).—Areas of Durkee stony clay loam having dominant slopes of more than 25 percent make up this phase. Relief is steep or semimountainous, surface runoff is very rapid in most places, and the soil is more susceptible to erosion than the less steep areas of Durkee stony clay loam. This soil resembles Durkee stony clay loam in most internal characteristics; but in most places it is shallower to bedrock, slightly less clayey in the subsoil, and more stony on and in the surface soil. It has a small total area.

Use and management.—This phase is used for range grazing; but because of its steeper slopes and greater surface runoff, it supports less vegetation than the normal phase and is of lower value for grazing. Because this soil is susceptible to erosion when not protected by a sufficient vegetative cover, it is especially important that all feasible measures be taken to increase the growth and density of the vegetation. Deferring grazing in the spring, removing the stock before the grasses are grazed too short, and proper distribution of drinking water and salt are practices that should increase the productivity of the range.

Durkee stony clay loam, eroded steep phase (25–45% slopes) (Dc).—This phase is severely sheet eroded or gullied. Owing to steep relief, it is naturally stonier, shallower, and more variable than Durkee stony clay loam; and in addition much of the original surface soil has been lost through erosion. The relief is semimountainous—mostly high domelike ridges cut by V-shaped ravines.

Use and management.—This eroded steep phase is used only for range grazing. Greater erosion and a shallower surface soil make its carrying capacity less than that of Durkee stony clay loam, steep phase. Encouraging vegetative growth is a highly desirable practice. Some areas may require reseeding. The practices recommended for Durkee stony clay loam, steep phase, also apply to this soil.



Big sagebrush and grass range on Durkee stony clay loam on hills in background. Rounded topography is that typically developed over the argillite rock underlying Durkee soils. Virtue Flat is just beyond the road.

GEM SERIES

The Gem series is made up of fairly dark well-drained soils of the uplands that have moderately well-defined profile layers and a calcareous subsoil. Gem soils are ordinarily developed on materials weathered from basic igneous bedrock, principally basalt, but in this area much phonolite and some andesite and volcanic tuff are also present in addition to the basalt. These rocks are very resistant to weathering, and Gem soils are consequently somewhat shallow and stony. The soils formed under an annual precipitation of 13 to 16 inches, including moderate snowfall. The natural vegetation is grasses, big sagebrush, and many flowering plants, including wild legumes. Most areas are rolling or hilly, but some are undulating and others are steep. Gem soils differ from the Ruckles and Lookout soils in being darker and richer in organic matter, in containing less lime, and in having developed in a less arid region.

Gem clay (2–25% slopes) (GA).—This clayey soil has a rather thin stony clay subsoil. It is of relatively small extent and typically occurs on gently rolling or rolling benchlike uplands. Slopes are dominantly in the 7- to 12-percent range. Surface drainage is medium to rapid, but internal drainage is slow. The water-holding capacity is fairly good but it is limited by the heavy texture and shallow profile. The soil does not contain excess soluble salts or alkali. Cheatgrass is the most common plant on overgrazed areas, but there is also much big bunchgrass and Sandberg bluegrass.

Profile description.—The surface soil, to a depth of about 10 inches, is dark grayish-brown, dark-gray, dark-brown, or grayish-brown clay or heavy clay loam. It is fairly high in organic matter, noncalcareous, and neutral in reaction. The layer is very dark grayish brown or very dark brown and plastic when wet. The upper 2 or 3 inches in virgin areas are root-bound and granular, but the lower part breaks into large granules. Some angular rock fragments are in and on the surface layer.

The upper subsoil, between depths of 10 and 20 inches, is brown or grayish-brown neutral or mildly alkaline compact very hard clay somewhat mottled with yellowish brown and grayish brown. It breaks vertically into subangular blocks or nutlike aggregates that have a vitreous coating on the fissure planes. The material is sticky and plastic when wet. This layer grades into brown or grayish-brown calcareous clay containing much segregated lime and a considerable number of partly disintegrated angular basalt fragments.

The subsoil, between 26 to 36 inches, contains many rock fragments. The material between the rocks is brown, very pale-brown, or yellowish-brown clay loam mixed with very light-gray or white calcareous material. This layer grades into the parent bedrock, principally basalt, at depths ranging from 16 to 50 inches but mostly at a depth of 36 inches.

Use and management.—Gem clay is used entirely for range pasture, a use to which it is well suited. Its grazing value is somewhat higher than average for the area. Some sheet erosion but very little gullying have followed overgrazing. The less stony areas probably would be fairly well suited to hay and pasture under irrigation, but most areas are on high dissected uplands where little or no irrigation water is

available. The stony areas included with this soil and shown on the map by stone symbols would be expensive to clear.

Gem clay, eroded phase (12–25% slopes) (GB).—This phase occurs on rolling to hilly uplands and has been appreciably eroded. It resembles Gem clay but its surface soil is thinner and more irregular in depth. The subsoil is exposed in small areas, and shallow gullies are fairly common. Some areas with slopes of less than 12 percent have been included. Surface drainage is rapid or very rapid. The soil has a small aggregate area. Its natural vegetation resembles that on Gem clay but the grazing value is lower. Grazing should be controlled to allow increased growth and density of the grass cover. Better vegetative growth will tend to check or prevent further erosion.

Gem clay, steep phase (25–45% slopes) (GD).—This phase consists of steep areas of Gem clay not severely eroded. The total area is very small. The soil resembles Gem clay in internal characteristics but is stonier, somewhat lighter colored, shallower to bedrock, and slightly less clayey in most places. Much of it has sustained slight or moderate erosion. Surface drainage is very rapid.

This soil is used for range grazing, but because of steep relief, very rapid surface runoff, and the shallow stony profile, it is of low value for that purpose. Grazing should be strictly controlled so that grasses and other grazing plants can increase their stand and growth. Controlled grazing will increase the productivity of the range and tend to check further erosion.

Gem clay, eroded steep phase (25–45% slopes) (Gc).—This phase differs from the steep phase of Gem clay in being more severely eroded or gullied. It resembles Gem clay in internal characteristics, but the surface soil is thinner, more irregular in depth, stonier, and somewhat lighter colored. The subsoil is exposed in places, is slightly less clayey than Gem clay, and bedrock is nearer to the surface. The phase has only a small total area.

Use and management.—This phase is used for range grazing, but the grazing value is low because of steep relief, very rapid surface runoff, the eroded condition, and the shallow stony profile. Most of the gullies probably formed following overgrazing, but it is probable that some existed before the area was settled. Grazing should be rigidly controlled so that grasses and other plants may have a chance to become better established. An increase in the vegetative cover will raise the productivity of the range and tend to check further erosion.

GLASGOW SERIES

Soils of Glasgow series have developed in upland areas, mainly from weathered volcanic tuff. In many places the tuff is capped by diatomite, and small areas developed over diatomite are included. The soils of this series are fairly extensive and are often associated with the Lookout and Brownlee soils. The relief is suggestive of dissected benches, and the Glasgow soils occupy the tops of the benches. The native vegetation is sagebrush, grass, and some scattered bitterbrush and mountain-mahogany. A few ponderosa pines grow west of Sparta.

Glasgow silt loam (2–12% slopes) (Ge).—The benchlike relief of this inextensive soil is fairly smooth. The larger areas are associated with the Lookout and Brownlee soils. The soil is well-drained, free of salts and alkali, and because of the shallowness to rock, it is only moderate in water-holding capacity. The subsoil is permeable.

Profile description.—To a depth of about 5 inches the surface soil is grayish-brown or slightly dark grayish-brown heavy silt loam to gritty clay loam of neutral reaction. This layer is very dark gray, very dark brown, or dark grayish-brown when wet, and in most places it is rather granular. Fragments of volcanic tuff are scattered on and in the soil. From a depth of about 5 to 10 inches the material is similar but breaks into small easily crumbled nutlike aggregates.

The subsoil is brown, mildly alkaline, moderately compact clay loam with a very weak prismatic structure. The color ranges from brown to pale-brown or grayish-brown, and the grayish shade is caused by a high content of decomposing volcanic tuff. The soil material breaks into small fairly easily crumbled aggregates and contains many fine roots. In most places a pale-brown or light brownish-gray calcareous clay loam lies between depths of about 24 and 26 inches. It grades into the white or very light-gray weathered volcanic tuff that continues downward to a depth of 20 feet or more. Where not exposed, the rock is nearly white, but is darker gray when weathered. The tuff is vesicular consolidated volcanic ash and other volcanic material of very light weight, but it is hard and contains pumicelike fragments. This eruptive material occurs in nearly horizontal strata and apparently was deposited in water and later hardened. Some rust-brown stains are on the upper part.

Included with this soil because of small extent and similarity are small areas northeast of Keating underlain by diatomite (7). These included areas, indicated by triangular symbols on the soil map, have a grayish-brown neutral friable loam surface soil to a depth of about 7 inches. This layer is somewhat granular and low in organic matter but it crumbles easily. Locally it is somewhat dark because of restricted drainage. Scattered rounded pebbles—mostly argillite, quartz, greenstone, and basalt—are in the soil in places and probably are derived from lascustrine or fluviatile material that covered the diatomite. The fine material is gritty when dry but sticky when wet.

The upper subsoil, from about 7 to 14 inches, is a pale- or yellowish-brown noncalcareous nearly neutral compact clay loam that breaks with an irregular prismatic structure. This layer grades into yellowish-brown or light yellowish-brown compact clay loam that breaks into angular blocks. There are many rust-brown stains. The material is mildly to moderately alkaline, and it is mildly calcareous in most places.

The parent material—very pale-brown clay loam mixed with white diatomite—is at an average depth of 24 inches, and it is underlain at a depth of about 36 inches by white diatomite. The diatomite, continuing to a depth of 10 feet or more, is consolidated, lies in distinct horizontal layers, and is penetrated by roots to a depth of 7 feet or more. The depth to the diatomite varies considerably in short distances, outcrops of the white material are common, and in many places the diatomite rests on volcanic tuff.

Use and management.—Glasgow silt loam is well suited to and is used mostly for pasture. Possibly 5 percent of it is cultivated, mainly to alfalfa and wheat. Yields are lower where the soil is dry-farmed. All of this soil has undergone some erosion caused by overgrazing.

The underlying volcanic tuff, below a depth of about 40 inches, is good building stone and especially desirable because of its high insulating quality. Some of the diatomite underlying this soil has been mined and is of fairly good commercial quality. Development of these deposits is handicapped because the nearest shipping point is more than 20 miles away.

Glasgow silt loam, eroded phase (2–12% slopes) (Gg).—This phase is of small total area and is composed of eroded areas of Glasgow silt loam having dominant slopes of less than 12 percent. It is similar to Glasgow silt loam, but its surface soil is shallower and more irregular in depth. Much of the original surface soil has been removed by sheet erosion, and the subsoil is exposed in places. Shallow gullies are fairly common.

Most of this eroded soil is used for range pasture; little is cultivated. Its grazing value is lower than that of Glasgow silt loam. Grazing should be controlled to prevent further damage by erosion.

Glasgow silt loam, gently sloping phase (2–7% slopes) (Gh).—Except for its more gentle relief and its being less subject to erosion, this phase is similar to Glasgow silt loam. It occurs in small bodies and is mostly under cultivation. Crop yields are the same as or slightly higher than for Glasgow silt loam.

Glasgow silt loam, hilly phase (12–25% slopes) (Gk).—Hilly and steep not severely eroded areas make up this phase. It occurs mostly on slopes below benches and around streamheads. It is similar to Glasgow silt loam but more variable in depth to bedrock and contains only a little lime in the subsoil.

This phase is used entirely for grazing. Overgrazing has allowed moderate erosion, for the soil is especially susceptible to erosion. Grazing should be controlled to increase the carrying capacity of the range and to check further erosion.

Glasgow silt loam, eroded hilly phase (12–25% slopes) (Gf).—This phase consists of severely eroded areas of Glasgow silt loam. It is similar to Glasgow silt loam; but because of the steeper relief, the surface soil is shallower and accumulation of lime in the subsoil is less. It occurs chiefly along ravines extending into high benches. Surface drainage is very rapid, and shallow gullies are fairly common. Included areas underlain by diatomaceous material but having about the same kind of soil and the same use are shown on the soil map by symbols.

The soil is used only for native pasture, for which it has a low value. Grazing should be restricted to prevent further erosion.

Glasgow stony loam (2–12% slopes) (Gl).—Except for the greater number of stones on the surface and in the profile, this soil resembles Glasgow silt loam. Typically it overlies volcanic tuff, but small included areas are underlain by diatomite. This soil is of small extent. It is slowly permeable but low in water-holding capacity

because of its shallowness to rock. It is well drained and free of salts and alkali.

Profile description.—The surface soil, extending to a depth of about 8 inches, consists of grayish-brown or slightly dark grayish-brown granular noncalcareous heavy loam or gritty clay loam containing many angular stones.

The subsoil, from 8 to 20 inches, is brown, pale-brown, or grayish-brown noncalcareous stony clay loam. The quantity of loose stones increases with depth; and owing to the large content of rock, the subsoil has no definite structure.

A pale-brown or light brownish-gray calcareous layer about 3 inches thick occurs at an average depth of 20 inches in some places. This rests on partly weathered light-gray or white volcanic tuff, the interstices of which contain some light brownish-gray and rust-brown noncalcareous gritty clay loam. This tuff is very hard to penetrate with a crowbar. Below an average depth of 40 inches the rock is solid and only little affected by weathering.

Use and management.—Glasgow stony loam is used only for native pasture and has a lower value for that use than most of the soils of the area. Over 25 percent of the surface soil has been lost through erosion.

Glasgow stony loam, eroded phase (2–12% slopes) (GN).—This eroded phase is similar to Glasgow stony loam but has a shallower and more irregular surface soil. The subsoil is exposed in places. The total acreage is small, and the grazing value is less than that of Glasgow stony loam. Grazing should be restricted to reduce further erosion.

Glasgow stony loam, hilly phase (12–25% slopes) (GP).—This phase consists of hilly or strongly sloping areas of Glasgow stony loam. The profile is similar to that of Glasgow stony loam; but because of stronger relief, less lime has accumulated in the subsoil. The grazing value is considerably lower because the slopes are steeper.

Glasgow stony loam, eroded hilly phase (12–25% slopes) (GM).—This phase consists of severely eroded or gullied hilly or strongly sloping areas. It is similar to Glasgow stony loam, but its surface soil is shallower and more irregular in depth, and the subsoil is exposed in places. Shallow gullies are common. Owing to stronger relief, there is less accumulation of lime in the subsoil. The grazing value of this soil is somewhat lower than that of Glasgow stony loam.

Glasgow stony loam, steep phase (25–45% slopes) (GR).—This phase is somewhat more variable than Glasgow stony loam. Much of it has sustained moderate erosion, which has been augmented by uncontrolled grazing. Outcrops of light-gray volcanic tuff are fairly common. Grazing should be rigidly controlled to check erosion and increase the density of range plants.

Glasgow stony loam, eroded steep phase (25–45% slopes) (GO).—Severely eroded or gullied steeply sloping areas make up this phase. It occurs mainly along ravines. It is similar to Glasgow stony loam, but its surface layer is shallower because of the loss of soil through sheet erosion, and its subsoil is more variable because of the steep relief.

Outcrops of light-gray tuff are common, and white diatomite crops out in places. The grazing value is low, and use should be restricted to control erosion.

Glasgow stony soils (12–45% slopes) (Gs).—These stony soils compose a complex of gravelly or stony medium- to heavy-textured soils on steep slopes where stratified material outcrops. Volcanic tuff, diatomite, and interstratified layers of gravel, conglomerate, and clay are among the materials on which the soils have developed. The complex is moderately extensive.

Profile description.—Owing to the steep relief and the stratified nature of the underlying materials, the surface soil ranges from gravelly stony loam to gravelly clay. Where erosion is not too severe the surface soil is grayish-brown to a depth of about 6 inches, and in such areas the subsoil is brown, grayish-brown, or pale-brown gravelly clay loam to a depth of about 18 inches. Many rounded stones are scattered on and in the soil. Argillite stones are most common, followed by quartzite, basalt, quartz, greenstone, and phonolite. The substratum consists of stratified material in which volcanic tuff and diatomite are conspicuous because of their light color.

Use and management.—Glasgow stony soils are very susceptible to erosion. Most areas have been damaged so much by sheet and gully erosion that they are of little value for grazing. The native vegetation is scattered sagebrush and grass, but there are many bare spots. Many of the gullies and bare areas probably were present before the area was settled, but erosion has greatly increased following overgrazing. Special control measures, such as the complete restriction of grazing and the planting of drought-resistant plants, are needed.

GOOCH SERIES

Soils of the Gooch series occupy poorly drained, level, nearly level, or basinlike areas on alluvial fans, stream bottom lands, and old lake bottoms. They have formed from recent assorted water-laid material of mixed geologic origin. The subsoil layers show little or no differentiation in structure or texture. These soils contain a variable quantity of excess soluble salts, and salty areas are shown on the map by alkali symbols or as an alkali phase. On the less salty areas the native vegetation is largely bluegrass and other grasses. Saltgrass, greasewood, and other alkali-tolerant plants grow on the more salty areas. A few scattered areas are very strongly alkaline and rather barren. Gooch soils are lighter colored than the Wingville and differ from the Baldock soils in having a slowly or very slowly permeable heavy layer in the subsoil or substrata.

Gooch silt loam (0–2% slopes) (Gt).—A small to moderate quantity of salts and alkali occurs in this soil and the quantity seems to be slowly increasing. Surface drainage is slow, and because of the moderately high water table and heavy-textured subsoil, underdrainage is poor. The natural vegetation is largely saltgrass, with some wild barley, alkali-grass, tall ryegrass, and other grasses, and in wet places tulegrass, flags, and other moisture-loving plants.

Profile description.—To an average depth of 5 inches the surface soil is light-gray or gray strongly alkaline calcareous silt loam. The material is root-bound in virgin areas, slightly platy, and dark gray or very dark gray when wet. It has a fair to low organic content. A

characteristic of the soil is the distinct variation in darkness that accompanies slight changes in moisture content. The lower part of the surface soil, occurring on the average between depths of 5 and 16 inches, consists of light-gray or gray calcareous friable silt loam that breaks into small angular easily crumbled aggregates. The two layers contain some excess soluble salts, and a trace of white efflorescence occurs at the surface when the soil is dry. The entire surface soil is free from gravel and stones and ranges from 10 to 20 inches or more in total thickness.

The subsoil, between about 16 and 36 inches, is light-gray or light-olive gray calcareous slightly compact silt loam. This layer is faintly variegated with gray and yellowish brown, contains a few rust-brown specks, and is dark gray or gray when moist. It has many fine roots and fine channels, is low in organic content, and contains much mica.

White or light-gray calcareous moderately or strongly alkaline slightly compact silty clay lies on the average between depths of 36 and 50 inches. The texture of this material varies from silty clay loam to clay, but it is always very slowly or slowly permeable to moisture and retards internal drainage of the soil. The depth to this heavy layer ranges from 24 to 60 inches, and the layer itself is of variable thickness.

Between depths of 50 and 60 inches the material is light-gray or white rather friable silt loam or silty clay loam. This layer has no definite structure but breaks easily. It is moderately to strongly alkaline and calcareous here and there. The lower part contains a very few pebbles. The material is gray when wet. In places a 10-inch layer of white volcanic ash occurs at this depth.

Light-gray clay loam containing much imbedded gravel lies between depths of 60 and 66 inches. It, in turn, rests on beds of light-gray, light brownish-gray, light olive-gray, or pale-olive porous water-worn gravel, sand, and small rounded cobblestones. These beds are generally noncalcareous and mildly or moderately alkaline, but in some areas near seeps from hot springs they are strongly alkaline. The depth to the gravelly substrata ranges from 3 to 7 feet. The gravel is water-logged much of the year.

Use and management.—Probably 20 percent of Gooch silt loam is under cultivation; a small area is used for native hay and the rest is in saltgrass pasture. Small grains, alfalfa, Ladino clover, and similar crops do fairly well, though there are many bare spots in cultivated fields. Barley and wheat are grown under irrigation. Some strawberry clover has been sown to improve the pastures.

The main problems of management are improvement of drainage, prevention of the accumulation of salts and alkali, and if possible, the reduction of salts and alkali content. The soil is not well adapted to irrigated crops because surface drainage is slow and the subsoil is very slowly or slowly permeable. The heavy subsoil layer favors the accumulation of soluble salts and increases the difficulty of removing such salts by repeated irrigations and improved drainage. Deposition has exceeded erosion on this soil.

Gooch silty clay loam (0–2% slopes) (Gu).—This soil is closely associated with other Gooch and the Wingville, Baldock, and Umapine soils. Natural surface drainage is slow, but most areas have been ditched to provide some surface runoff. Internal drainage is re-

stricted by the clayey very slowly or slowly permeable layer in the subsoil and also by the moderately high water table in the porous substratum. Much of the material is probably partly lake-laid, but the coarse substrata are obviously stream-laid. The vegetation is largely bluegrass, tall ryegrass, other grasses, mullein, flags, wild rose, and thistle. Considerable saltgrass grows on saline areas.

Profile description.—The surface soil is free of stones and pebbles but contains a small quantity of mica. In virgin areas the upper part (to a depth of 5 inches) is gray root-bound friable calcareous silty clay loam. This part is very dark gray or nearly black when wet, moderate or fair in organic content, and moderately to strongly alkaline in most places. In small areas, however, it is very strongly alkaline. A trace of white efflorescence is sometimes found on the surface after the soil has dried following a prolonged wet period.

Between depths of 5 and 17 inches, the material is similar or slightly lighter in color and slightly lower in organic-matter content than the upper layer. It breaks with a faint vertical cleavage into small easily crumbled aggregates.

The subsoil may contain layers of plastic clay at any depth, and it is variable below a depth of 36 inches. Between depths of 17 and 38 inches it is light-gray or white firm or somewhat compact clay or silty clay loam. It is very slowly or slowly permeable to water, generally calcareous in the upper part, and less calcareous with increasing depth. There are many fine roots and numerous fine channels. Like other parts of the subsoil, this layer contains some fine rust-brown and gray mottlings. It is gray or grayish brown when wet. This material passes into light-gray or very pale-brown slightly compact but friable silty clay loam or clay.

The material between depths of 50 and 60 inches is light-gray or very pale-brown silty clay loam or clay loam containing a very few imbedded pebbles in some places. It is generally noncalcareous and mildly or moderately alkaline.

The material between depths of 60 and 65 inches is light-gray or light olive-gray clay mottled with rust brown and light bluish gray. It contains much imbedded gravel and rests on stratified beds of light-gray or light olive-gray very porous gravel, sand, and finer sediments. The depth to the gravelly substratum is variable and ranges from 36 to 80 inches or more.

Use and management.—Probably 60 percent of Gooch silty clay loam is under cultivation; the rest is used for native hay and pasture. Bluegrass and timothy are grown under irrigation on about 40 percent of the cultivated area and produce an average yield of 1¾ tons an acre. Wheat, barley, and a little alfalfa are grown. Because of the moderately high water table, alfalfa soon dies out.

Owing to the nearly level relief, there has been no appreciable erosion. The salinity apparently is increasing because drainage is deficient and because soluble salts are being carried in by irrigation water, by runoff from other soils, and by water from strongly alkaline hot springs. Some standing irrigation water is allowed to evaporate on the surface, and this leaves an accumulation of soluble salts.

The soil needs better drainage, which could be accomplished by constructing deeper ditches and canals to carry off standing surface water and to lower the water table. The very slowly or slowly

permeable layer in the subsoil increases the hazard of salt accumulation in the surface soil and increases the difficulty of removing it by controlled irrigation and drainage.

Gooch silty clay loam, alkali phase (0–2% slopes) (Gv).—The surface soil and upper subsoil of this phase contain a trace of mica and are free of stones and pebbles. Surface drainage is slow, and internal drainage is restricted by the heavy surface soil and subsoil. The natural vegetation is largely saltgrass, other grasses, and scattered greasewood, sagebrush, and rabbitbrush.

Profile description.—The surface soil is light-gray or nearly white calcareous silty clay loam to an average depth of 14 inches. The color changes to grayish brown or slightly dark gray when the soil is wet. The upper 5 inches of this layer is more or less root-bound in virgin areas, fair to low in organic-matter content, and somewhat platy to granular. The lower part breaks into cubelike aggregates. The entire surface soil is sticky when wet. It is generally strongly alkaline, but the range is from moderately to very strongly alkaline.

The layer between depths of about 14 and 24 inches is light-gray or white calcareous firm or rather compact silty clay loam that breaks into large pieces with no distinct cleavage. It contains many fine roots and numerous fine channels. It contains a trace of grayish variegation and rust-brown specks. In places the material is silty clay with a faint vertical breakage.

Between average depths of 24 and 36 inches, the subsoil is light-gray or very pale-brown calcareous firm or slightly compact silty clay loam or clay loam that breaks into irregular nutlike aggregates the size of a pea or smaller. This material contains a trace of white segregated lime in places, many fine channels, and a trace of gray and rust-brown variegation. It grades into white or very light-gray rather compact calcareous silty clay or silty clay loam that contains many specks and streaks of rust brown and yellow, and in places thin layers of very pale-brown fine sand. This layer is sticky and light brownish gray or light olive gray when wet, and it is very slowly permeable to water.

The material between depths of 50 and 72 inches is variable. Stratified layers of pale-olive, light yellowish-brown, bluish gray, and gray fine sand and clay occur in many places, but commonly a 6-inch layer of pale-olive or light olive-gray clay containing many round imbedded pebbles lies just below a depth of 50 inches. This layer, in turn, rests on stratified layers of pale-olive, light yellowish-brown, light olive-gray, or gray porous gravel and sand that contain some small rounded cobblestones. The depth to the gravelly substratum varies from 36 to 80 inches or more.

The porous gravelly material of the substratum is waterlogged in spring. The water table recedes during summer but is always fairly high. The gravelly layer is slightly limy in the upper part but becomes less limy with increase in depth. It ranges from moderately to strongly alkaline. The ground water is strongly alkaline in some areas north of Baker, probably because highly alkaline hot springs are in that locality.

Use and management.—About 15 to 20 percent of Gooch silty clay loam, alkali phase, is cultivated, mostly to barley, wheat, and some alfalfa. The rest of the land is used for native hay and pasture.

Native hay produces about 1 to 1¼ tons an acre if it is irrigated with floodwater in early spring. The soil is irrigated by flooding through shallow ditches. Deposition of silt from gold placer mines has more than compensated for any erosion.

The amount of salts and alkali is apparently increasing slowly and if allowed to continue may in time make the soil unproductive. Small scattered areas in cultivated fields are now rather barren because of alkali. Most of the soil contains moderate to slight quantities of salts and alkali, but not enough to injure small grains. More deep ditches are needed to lower the water-table and to carry off surplus irrigation water so it will not evaporate on the surface. The excess accumulation of soluble salts in the soil is rather difficult to remove by repeated irrigations because water moves slowly through the clayey layers.

GRAVEL PITS

Gravel pits (Gw) are excavations where commercial gravel and sand have been removed for surfacing roads and for other purposes. They have little or no agricultural value.

HAINES SERIES

Soil of the Haines series is formed on poorly drained alluvial and lake-laid materials of mixed geologic origin under a cover of saltgrass. The annual precipitation is 10 to 12 inches. The Haines soil contains much alkali and has the lightest gray surface layer of any soil in the area. It differs from the associated and related Umapine and Baldock soils in having a layer of volcanic ash in the lower part of the profile, a lighter colored surface soil, and a feebly cemented subsoil.

Haines silt loam (0–2% slopes) (Ha).—This soil occurs in level or basinlike areas on stream bottoms or old lake bottoms where surface drainage is slow and underdrainage is poor. The larger areas are associated with the Umapine, Baldock, and Gooch soils. In spring much of the soil is covered with shallow water. Erosion is negligible. The parent material comes largely from lava, granite, argillite, and other kinds of metamorphic rock. The sod-bound surface layer in virgin areas contains considerable organic matter, but below this part of the profile the content is apparently low. The surface soil is free of stones and gravel but high in content of salts and alkali. The soil profile is fairly permeable to water, but only roots of alkali-tolerant plants penetrate the subsoil. The natural vegetation is mostly saltgrass and some scattered greasewood and flowering plants. Some wild barley, white clover, and alkali-grass grow in places, and tulegrass and flags in wet spots.

Profile description.—The surface soil of virgin areas to depths of 1 to 4 inches is light brownish-gray or grayish-brown more or less platy friable calcareous silt loam that contains much salt and alkali. It is strongly root-bound, is grayish brown when moist, and grades into very light gray or white highly calcareous somewhat compact silt loam. This lower layer has a fine platy structure in the upper part. It is grayish brown when moist.

The layer between depths of 12 and 20 inches is very light-gray or white highly calcareous strongly or very strongly alkaline compact silt loam. The material breaks with a faint vertical cleavage into irregular aggregates, some of which are small and weakly cemented.

This layer is one of the most conspicuous features of the soil. The depth to this layer ranges from 6 to 26 inches or more.

From a depth of 20 to 36 inches the subsoil is white or very light-gray calcareous silt loam. This layer is light brownish gray or grayish brown when moist and contains many fine holes from old root channels and a trace of grayish-brown variegation. The material from 36 to 48 inches is white or light-gray silt loam or loam, calcareous in places, that contains much mica and a trace of gravel.

Below 48 inches there may be a 6- to 12-inch layer of white or very light-colored very fine sandy loam (volcanic ash). This layer is of sporadic occurrence. Following is a thin layer of light-gray silt loam or clay loam containing much imbedded gravel, and abruptly below this layer at an average depth of 60 inches are stratified beds of light-gray gravel and sand. The gravelly substrata are calcareous only in places, free of alkali, and more than 5 feet thick.

Between depths of 24 and 60 inches the soil material may be stratified and may contain layers of sand and clay and occasionally a dark grayish-brown buried surface soil.

Use and management.—Nearly all of Haines silt loam is used for saltgrass pasture, to which it is well suited. As it is more or less subirrigated, the soil is grazed from spring until early fall. Small areas are cultivated, mostly to barley, but crops are spotty and yields are low. Some strawberry clover is being tried and is yielding satisfactorily.

Poor drainage and the presence of salts and alkali are the greatest drawbacks. The salinity is increasing in the surface soil because soluble salts are being added from floodwaters. On evaporating, the floodwater leaves a film of soluble materials on the surface. Some salt is probably carried up by roots, capillarity, and hydrostatic pressure, but the substrata are relatively noncalcareous and free of alkali and therefore are a minor source of the surface salt. Further increase in salinity content can be prevented by constructing canals to remove surface water before it evaporates. Most of the salt probably can be removed by irrigation and drainage. These operations would be rather expensive because the soil is nearly level and there is a shortage of water for such reclamation purposes. The soil probably would be fairly productive under good management if reclaimed from salts and alkali.

HALFWAY SERIES

Soils of the Halfway series have developed under imperfect to moderately good drainage on mixed alluvial-fan material derived principally from basalt and granite. The annual precipitation ranges from 17 to 25 inches. The entire profile of these soils is noncalcareous and neutral or slightly acid. The natural vegetation is predominantly grass. Halfway soils are very productive when irrigated. They differ from the associated and related Langrell soils in being less well drained and in having a more clayey subsoil. They are less dark, are better drained, and have a more clayey subsoil than the Catherine soils. They have a darker surface soil and are less well drained than Applegate soils.

Halfway clay loam (0–2% slopes) (Hc).—This dark-colored noncalcareous soil formed in swales and basinlike areas from young

alluvial-fan material of mixed geologic origin. This soil is associated with other Halfway soils, as well as with the Langrell soils. Surface drainage is slow but adequate for grain and hay crops; internal drainage is slow. The soil is slowly permeable to water, high in water-holding capacity, and entirely free of salts and alkali. Its surface layer is high in organic-matter content. Owing to the smooth nearly level relief, erosion has been negligible. The native vegetation consists mostly of grass and a few scattered aspens, willows, black haws, ponderosa pine, rosebushes, and other trees and shrubs. Bluegrass, pinegrass, and orchard grass are common.

Profile description.—The surface soil is dark grayish-brown or dark-gray granular friable clay loam to an average depth of 10 inches. When moist, it is very dark brown or almost black. The upper part is sod-bound in virgin areas. Practically no gravel or stones are on the surface.

The upper subsoil between depths of 10 and 20 inches is dark grayish-brown or dark-brown somewhat compact heavy clay loam that breaks into medium-sized angular faintly prismatic aggregates. There are many fine roots. Most roots penetrate the aggregates, but many follow the fissures. The texture ranges from clay loam to clay.

The subsoil between depths of 20 and 30 inches is dark grayish-brown rather compact clay having a prismatic structure. The prisms break into irregular nut-sized aggregates. The subsoil between average depths of 30 and 44 inches is dark grayish-brown to brown rather compact clay mottled with rust brown or yellowish to reddish brown. It breaks with a vertical cleavage into large angular aggregates and contains some gravel.

The lower subsoil, between depths of 44 and 60 inches, ranges from dark grayish-brown clay loam to brown gravelly clay loam. This layer is variable and may include layers of clay, loam, sandy loam, gravel, or occasionally a thin layer of white diatomaceous earth or volcanic ash. All of it is faintly variegated with rust brown or yellowish red.

The substrata, occurring below an average depth of 60 inches, consist of brown, grayish-brown, and yellowish-brown gravelly clay loam, gravelly sandy loam, clay loam, water-worn cobblestones, or gravel. The material is generally moist. The depth of the soil to the gravelly substrata ranges from 3 to 8 feet or more.

Use and management.—Practically all of Halfway clay loam is cultivated under irrigation. Grain—including wheat, barley, and oats—and hay are the crops grown. Barley and oats occasionally yield over 100 bushels an acre.

Halfway clay (0–2% slopes) (Hʙ).—Level or basinlike areas on alluvial fans are occupied by this soil. It occurs in association with other Halfway soils and those of the Langrell series. It is derived from heavy-textured mixed alluvium. Internal drainage is slow or somewhat restricted. Owing to the slow surface runoff, erosion has been negligible. The water-holding capacity is good. The soil has a high organic content and a fairly good structure. A heavy growth of grass covers virgin areas.

Profile description.—To an average depth of 4 inches the surface soil is dark-gray clay of platy appearance that crumbles into pea-sized

granules when dry. It is nearly black, and sticky and plastic when wet. It is strongly root-bound under virgin conditions. The lower part of the surface soil, between depths of 4 and 14 inches, is dark-gray waxy clay that breaks into large angular blocks and then into small cubelike aggregates. This material is nearly black when moist. The two layers of surface soil have a high organic content and are free of stones, but they contain a trace of gravel.

The upper subsoil, from a depth of 14 to 24 inches, is grayish-brown or dark grayish-brown plastic clay that breaks with vertical cleavage into somewhat long aggregates. There are many fine root channels. Between depths of 24 to 30 inches, the subsoil may be grayish-brown somewhat compact clay that breaks into small angular prisms that are gray-coated in places. This layer is of irregular occurrence and may be missing. Where it occurs, it passes abruptly into brown clay variegated with yellowish-brown and containing some rust-brown mottling. This clay material generally contains few pebbles and breaks into irregular clods.

The material between depths of 40 and 60 inches is more permeable and more yellowish. In addition, it is somewhat stratified and contains much imbedded gravel and thin layers of sand.

Stratified beds of porous gravel, sand, and rounded cobblestones may occur at any depth between 3 and 8 feet. These beds commonly exceed 10 feet in thickness and are generally waterlogged.

Included with this soil are gravelly areas shown on the soil map by gravel symbols. In these areas the surface soil, to an average depth of 10 inches, is dark-gray plastic clay more or less variegated with yellowish brown and gray. Much gravel is scattered on and in this layer. The upper subsoil, between depths of 10 and 24 inches, consists of grayish-brown plastic clay mottled with rust-brown and gray. This clay occurs as a matrix between cobblestones. The material is tough and difficult to penetrate with a crowbar because of the high stone content. The subsoil from a depth of 24 to 36 inches is generally a yellowish-brown firm or rather compact gravelly or cobbly loam.

Below a depth of 36 inches and extending to 60 inches or more, the material is brown or yellowish-brown coarse porous gravelly or cobbly loam with layers of gravelly clay loam. The water table is at a depth of 3 or 4 feet. This included soil is seldom flooded, but it is generally soggy.

Use and management.—Probably 75 percent of Halfway clay is cultivated, principally to grains and clover-and-timothy hay. Drainage is inadequate for alfalfa. Native bluegrass produces about 1½ tons of hay an acre, when irrigated. The gravelly areas covering about 200 acres are used mostly for native pasture. A small area of this included gravelly soil has been cultivated but has been allowed to revert to pasture. It is very difficult to cultivate because of the gravelly plastic nature of the surface soil.

Halfway silt loam (0–2% slopes) (HD).—This dark-colored soil occurs on level or nearly level alluvial fans, mostly in broad swales along small streams. The surface soil is almost free of stones, but it and the upper subsoil usually contain a little gravel. Surface drainage is slow but adequate for most grain, hay, and pasture crops. Internal drainage is medium to slow. The soil profile is moderately

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to slowly permeable, high in water-holding capacity, and free of salts and alkali. The supply of organic matter in the surface soil is high. Erosion is negligible. The natural vegetation is mostly grass, but there are a few scattered clumps of aspen, willow, black haw, mullein, thistle, and other trees and weeds.

Profile description.—Halfway silt loam shows moderate differentiation in texture and structure of subsoil layers. To an average depth of 6 inches the surface soil is dark grayish-brown or dark-gray granular friable silt loam. The material is root-bound in virgin areas. The lower surface soil between 6 and 14 inches is somewhat dark grayish-brown or dark-gray heavy silt loam that crumbles into small nut- or pea-sized aggregates. The surface layers are very dark gray or nearly black when wet.

The upper subsoil occurs between average depths of 14 and 24 inches. It is dark grayish-brown, dark-brown, or brown firm prismatic clay loam. It is faintly variegated with rust brown or yellowish red and breaks into large fairly easily crumbled blocks about 6 inches high and 3 inches wide. This material passes into a grayish-brown firm heavy silt loam.

The lower subsoil between 30 and 48 inches is dark grayish-brown or brown friable silt loam containing a few pebbles and a trace of rust-brown and yellowish-red mottlings. Seams of fine sand are present in places. The texture is coarser with increasing depth. This material grades into a brown or grayish-brown very fine sandy loam with some grayish and rust-brown mottlings. Buried soil layers are fairly common in the lower subsoil.

Porous stratified layers of grayish-brown sand, gravel, and small cobblestones occur below an average depth of 56 inches. The water table generally stands at depths of about 6 to 8 feet.

Use and management.—Most of Halfway silt loam has been cultivated, but much of it is kept in bluegrass and orchard grass for pasture and hay. The relatively high water table is not good for alfalfa but it subirrigates other crops.

HERSHAL SERIES

Soils of the Hershal series formed under poor drainage on level or nearly level stream bottom lands, alluvial fans, and low terraces. The cover was grass or an open stand of willows, cottonwoods, aspens, and other trees. The annual precipitation is about 17 to 30 inches. The ground is frozen and covered with snow during part of the winter. The soils are very young, or recent, and their profiles show no or very slight differentiation of textural horizons. They differ from Catherine soils in having browner, lighter colored surface soil.

Hershal silt loam (0–2% slopes) (He).—This type has very slight or no differentiation of textural or structural profile layers. It occurs near the Halfway and Langrell soils on nearly level stream bottom land and alluvial fans. It contains much mica and is neutral to medium acid in reaction and noncalcareous throughout. The soil is often flooded during spring thaws and after heavy rains. Water does not remain long, but the surface soil is generally moist. Underdrainage is poor because the water table is usually at a depth of 2 feet. The soil is moderately to rapidly permeable to roots and water and has a good water-holding capacity.

Profile description.—The surface soil, to an average depth of 9 inches, is dark grayish-brown faintly crumbly or granular silt loam containing some fine rust-brown mottlings in the lower part. When moist, this material is very dark brown. It is fairly high in organic content and contains a small quantity of gravel. To a depth of about 20 inches it grades into grayish-brown friable silt loam mottled with rust brown, yellowish red, yellowish brown, and gray. This material also contains some gravel.

At a depth of about 20 inches the material is grayish-brown, bluish-gray, or light brownish-gray friable silt loam mottled with rust brown, gray, and yellowish red. This material contains more or less gravel and occasionally thin layers of sandy loam or clay loam. Between depths of 30 and 40 inches the subsoil is usually waterlogged grayish-brown, bluish-gray, or light brownish-gray very fine sandy loam or sandy loam mottled with rust brown. The layer contains considerable gravel and few small cobblestones coated with a rust-brown film of soil. Buried wood and buried soil layers are common. The material is rather gray when dry.

Between depths of 40 and 60 inches are stratified layers of mottled gray, yellowish-brown, and rust-brown gravel, sand, and water-worn cobblestones. The stones are mostly of granite, but some are of basalt, greenstone, or other rock materials.

Use and management.—Hershel silt loam is used almost entirely for pasture and is highly valued for that purpose. The pasture is mostly bluegrass, though there is also some white and alsike clovers, orchard grass, and pinegrass. Owing to the smooth relief and good grass cover, practically no erosion has occurred.

Hershal silt loam, gravelly subsoil phase (0–2% slopes) (HF).—Except for its shallower depth to gravelly material and its less bluish-gray subsoil, this phase is similar to Hershal silt loam in most respects. It is associated with the McEwen and Catherine soils and occurs on level or nearly level stream bottom lands (pl. 2), alluvial fans, and low terraces. Surface drainage is slow. The subsoil is moderately or rapidly permeable, but underdrainage is restricted by a high water table. The soil, as a whole, has a good water-holding capacity. The surface soil and subsoil are noncalcareous, neutral or slightly acid, and free of salts and alkali. There is much mica throughout the profile.

Profile description.—To a depth of 8 inches the surface soil is dark-gray, dark grayish-brown, or grayish-brown silt loam with a trace of rust-brown fine mottling. It is somewhat platy but crumbly, very dark brown or black when wet, and fairly high in content of organic matter. Below this is slightly lighter colored silt loam that continues to a depth of 13 to 20 inches. This horizon breaks with a faint vertical cleavage into small easily crumbled aggregates of fairly high organic content. Both layers are somewhat gravelly in places.

From 20 to 30 inches the subsoil is gray, grayish-brown, or light brownish-gray friable to firm loam, silt loam, or heavy silt loam that shows a trace of yellow and rust-brown fine mottling. Dark-gray buried surface soil layers occur at this depth in places but are not representative. The material at this depth in some places includes layers of fine sandy loam, silt loam, and clay loam, and much gravel in the lower part. The underlying strata consist of layers of grayish-brown, light brownish-gray, or light olive-gray gravel, sand, and cobblestones.

The fine sediments occur as interstitial material between the stones and gravel. Tests have shown that the gravelly substratum extends downward to depths of 15 to 35 feet, where it lies on clay. The material is of mixed mineralogic origin but is derived largely from granite, argillite, quartzite, basalt, and related rock.

Several areas included with this soil have the gravelly substratum at a depth slightly greater than 30 inches and in places as deep as 42 inches. These areas are slightly more productive because of their greater depth to gravelly material.

Use and management.—Most of this phase has been cleared and is used largely for hay and pasture. A mixture of bluegrass, timothy, alsike clover, and other grasses is grown on about 75 percent of the land. Some oats are grown. Wheat cannot be grown in Sumpter Valley because the growing season is too short. Alfalfa is short-lived because of the high water table. Nonetheless, the high water table is a source of water for subirrigating grass and it helps make this a valuable grazing soil. Drainage could be improved, but if this were done the grazing capacity would probably be decreased. The growing season is short and the soil is therefore best suited to hay and pasture crops.

Owing to the nearly level relief, erosion is not a problem. Some areas have been covered with a thin coat of wash from placer mines. Considerable areas of the soil have been destroyed by placer diggings, and more probably will be in the future.

HIBBARD SERIES

The somewhat dark soils of the Hibbard series are developed in old fluviatile or lacustrine deposits under a cover of grass and sagebrush where the annual precipitation is 13 to 16 inches. They occur on more or less eroded high benches and fans, generally at the foot of mountains or hills composed of argillite rock. Relief typically is undulating or gently rolling. Hibbard soils are not extensive.

Hibbard silt loam (2–12% slopes) (Ho).—This soil has a strongly differentiated subsoil and a zone of lime accumulation. It occurs primarily on weakly dissected high terraces or benches of gently sloping or rolling relief. Some areas occur in broad swales. Surface drainage is slow to medium; internal drainage is very slow or slow but generally adequate. The waterholding capacity is good, and the soil does not contain excess soluble salts. Roots and moisture penetrate fairly well, although the subsoil is very tough and compact. The natural vegetation is grass, sagebrush, some rabbitbrush, and other shrubs and flowering plants.

Profile description.—To an average depth of 12 inches the surface soil is dark-gray, dark grayish-brown, or grayish-brown friable heavy silt loam or silty clay loam. This material is nearly black or very dark brown and sticky when wet. The upper part is granular, but the lower part breaks on vertical cleavage planes into angular fragments that are readily reduced to easily crumbled nut- and pea-sized aggregates. The surface soil ordinarily is slightly stony.

The upper subsoil is brown tough dense compact prismatic clay variegated with grayish brown. It may contain some rounded pebbles and small cobblestones, is difficult to penetrate with a crowbar, and breaks first into large masses and then into smaller aggregates that are

hard to crumble. Like the surface soil, it is noncalcareous and about neutral in reaction. Numerous roots follow the fissure planes and some penetrate the aggregates.

At a depth of about 36 inches the material just described is abruptly replaced by variegated light yellowish-brown, rust-brown, and grayish-brown cemented clay loam or loam that contains more or less gravel. This layer is about 12 inches thick. It is generally highly calcareous, but the lime content does vary greatly within short distances. It contains much less lime than this part of other Hibbard soils.

Next in profile is a light yellowish-brown heavy loam that contains more or less rounded cobblestones and pebbles and is less calcareous with depth. Its color ranges from pale brown to pale yellow, with rust-brown and gray variegations. The texture varies from gritty clay loam to a coarse gravelly loam.

The substrata, below a depth of 6 feet, consist of layers of brownish-yellow or very pale-brown clay, clay loam, loam, and gravelly material. The cobblestones and small stones are largely argillite and quartzite and are very hard and resistant to weathering.

Areas of this soil north of Lower Powder Valley differ from others in having a less calcareous subsoil and a parent material that includes much greenstone and volcanic tuff.

Use and management.—About 60 percent of Hibbard silt loam is cultivated, the greater part under irrigation. Alfalfa, wheat, and oats are the main crops. Dry-farmed wheat produces 15 to 20 bushels an acre if the land is summer fallowed. Alfalfa yields about 175 pounds of seed an acre under dry-farming conditions. Uncleared areas are used for native pasture and are better than the average uplands for that purpose. The grazing season is divided between spring and late fall and covers about 5 months in all. The soil is moderately susceptible to erosion, and most of the cultivated areas show appreciable loss of soil material.

Hibbard silt loam, eroded phase (2–12% slopes) (HP).—Except for being more or less severely eroded, this phase resembles Hibbard silt loam. Many areas are gullied, and others have lost 75 percent or more of the surface soil. The subsoil is exposed in places. Conspicuous gullies are shown by symbols on the soil map. In some places a considerable number of rounded gravel and cobblestones are scattered over the surface.

Little of this soil is cultivated. Apparently it has been badly overstocked. Its present grazing value is low, and grazing should be rigidly controlled to prevent further erosion.

Hibbard silt loam, hilly phase (12–25% slopes) (HR).—This phase occurs in ravines and on slopes below high eroded benches. It is used for range grazing and, among the soils of the uplands, is a little better than average for this purpose.

Hibbard clay (0–12% slopes) (HG).—The soil occurs on dissected slopping terraces and alluvial fans and has undulating to gently rolling relief. Slopes of 5 to 10 percent are dominant, though the range is from 0 to 12 percent. The organic content of the surface soil is fairly high. The soil is slowly to very slowly permeable. The water-holding capacity is good, but internal drainage is restricted. There is no excess of soluble salts or alkali.

Profile description.—The surface soil, to a depth of about 6 inches, is dark-gray clay or heavy silty clay loam. This material is nearly black when wet, root-bound in virgin areas, and of distinct granular structure. It grades into slightly less dark clay of fine nutlike structure, which is waxy and sticky when wet but fairly easily broken when dry. In total thickness the dark surface layers range from 10 to 16 inches or more, but the average is 12. A small quantity of rounded and subangular cobblestones and pebbles may occur in any part of the profile, but the quantity in the surface layers is not enough to interfere with cultivation.

The upper subsoil from a depth of 12 to 20 inches is dark grayish-brown or brown dense plastic clay of irregular prismatic structure. Most of the roots follow the fissure planes but some penetrate the soil mass.

The upper subsoil layer grades into a brown very compact clay, which is plastic when wet and refractory when dry. This material is difficult to penetrate with a bar and breaks on irregular vertical cleavage planes into dense angular aggregates that are hard to crush. Like the surface soil, this layer is about neutral in reaction and noncalcareous. In color it ranges from brown to yellowish brown with rust-brown and grayish-brown variegations. It becomes yellower with depth.

At a depth of about 34 inches the subsoil grades into calcareous light yellowish-brown clay with fine rust-brown and grayish-brown mottlings. Replacing this at an average depth of 44 inches and continuing downward about 2 feet is a pale-yellow compact calcareous clay loam in which there is much white segregated calcium carbonate. The reaction of this layer is mildly alkaline.

Below about 6 feet is brownish-yellow clay loam with imbedded cobblestones and gravel and stratified layers of gravelly loam and other coarse materials. The cobblestones and gravel are largely argillite but quartzite, granite, basalt, and other kinds of rock are included.

Use and management.—Uncleared areas of Hibbard clay provide good native pasture. The land is grazed in spring and fall for a total grazing period of 5 months. Probably 40 percent of the soil in Baker Valley is cultivated, but none is cultivated around the Lower Powder Valley. Oats, alfalfa, and wheat are the common crops. The soil is difficult to cultivate because it is clayey and sticky. The good cover of vegetation and the fairly gentle relief have prevented serious surface erosion on most of this soil.

Hibbard clay, eroded phase (2–12% slopes) (HK).—There are many gullies in this phase, and in places 75 percent or more of the surface soil has been lost through accelerated erosion. In many places the subsoil is exposed. The more conspicuous gullies are shown by symbols on the soil map. Except for erosion, the soil is similar to Hibbard clay.

Practically none of this soil is cultivated. It is used for range pasture, for which it has a rather low suitability. Much of it occurs along the old Oregon Trail and is rutted and scarred by old wagon roads.

Hibbard clay, moderately steep phase (12–25% slopes) (HL).—Except for its steeper slopes and the resulting differences in surface runoff, erosiveness, and ease of tillage, this soil is similar to Hibbard

clay. It occurs on slopes between high benches and the larger streams and in ravines.

It is used only for native pasture, and its suitability for this use is about average or a little better than average for the area. There is some sheet erosion caused by overgrazing.

Hibbard clay, eroded moderately steep phase (12–25% slopes) (HE).—Although resembling Hibbard clay, moderately steep phase, in most respects, this phase differs in having been severely eroded. Much of the land is gullied, and 75 percent or more of the surface soil has been removed over a large part by erosion. Rounded cobblestones and gravel are common on the surface. The soil occurs principally on hillsides below high benches. It is used for range pasture but is of low grazing value. Grazing should be restricted to increase the vegetative cover and prevent further damage by erosion.

Hibbard stony clay (2–12% slopes) (Hs).—A striking feature of this soil is the great number of rounded cobblestones and small stones on the surface and in the profile. These cobblestones are mostly quartzites but same are of argillite, milky quartz, granite, and other rocks. This soil occurs on dissected benches, and the relief is typically gently rolling or rolling. The water-holding capacity is good. Moisture penetrates very slowly, but the subsoil is not impermeable. Roots go down to the caliche layer. The natural vegetation is grass, sagebrush, and some rabbitbrush, mountain-mahogany, and other shrubs and flowering plants.

Profile description.—To a depth of 6 inches the surface soil is dark grayish-brown or dark-gray granular stony clay or stony silty clay loam. It is sticky, waxy, and very dark brown or nearly black when wet, is almost carpeted with stones in places, and contains a large quantity of stones and gravel. The material is moderately or fairly high in organic content. This layer passes into slightly less dark stony clay or heavy silty clay loam. Both surface layers are generally noncalcareous and almost neutral in reaction.

The subsoil between depths of about 12 and 36 inches is dark grayish-brown or brown tough compact cobbly clay. This material is generally calcareous and contains some segregated specks of white lime. It breaks with a vertical cleavage into dense nutlike aggregates that have a faint lustrous coating on the fissure planes. The content of rocks is so large that it is difficult to pentrate this layer with a crowbar.

A very pale brown or white caliche hardpan 1 or 2 feet thick is at depths ranging from 24 to 48 inches and averaging 36. This hardpan consists of rounded cobblestones 2 to 8 inches in diameter set in white or very pale-brown lime or other cementing material. It is very compact and difficult to penetrate. Below depths of 60 to 70 inches the material is less calcareous and less compact. Deeper down, the substrata are old fluviatile deposits ranging from coarse alluvium to clay loams.

Use and management.—Hibbard stony clay is not farmed, for it is too stony to cultivate. Its suitability for grazing is about average for the uplands. A moderate amount of sheet erosion has resulted from overgrazing.

Hibbard stony clay, eroded phase (2–12% slopes) (HU).—Much of this phase occurs along the old Oregon Trail and is rutted by the many old wagon roads. About 75 percent of the surface soil has been

washed away. Many areas are gullied and in numerous places the surface soil is entirely gone and the subsoil is exposed. Except for erosion, the soil is similar to Hibbard stony clay. The more clearly marked gullies are shown by symbols on the soil map.

Overgrazing has resulted in much erosion, and future use must be carefully regulated if further damage is to be avoided. The present grazing value is low.

Hibbard stony clay, moderately steep phase (12–25% slopes) (Hw).—This soil occurs on dissected old terraces and differs from Hibbard stony clay mainly in having steeper relief. The dark surface soil is more variable in depth but generally not so deep as that of Hibbard stony clay, and probably a little more stony. The soil washes easily because of its strong slopes, and most areas have been damaged by much sheet erosion caused by heavy grazing. None of the land is cultivated.

Hibbard stony clay, eroded moderately steep phase (12–25% slopes) (Ht).—This phase is similar to Hibbard stony clay, moderately steep phase but is more gullied or eroded. Accelerated erosion has removed 75 percent or more of the surface soil, and in places the subsoil is exposed. The more prominent gullies are indicated by symbols on the soil map.

None of this soil is cultivated. The present grazing value is low as a result of severe use in the past. Future grazing should be carefully controlled to forestall further damage and give the range an opportunity to recover.

Hibbard stony clay, eroded steep phase (25–45% slopes) (Hv).—Steep eroded areas make up this phase. It resembles Hibbard stony clay in significant profile characteristics but is much more variable because of its steep relief. Many areas are cut by shallow gullies, and elsewhere much of the surface soil has been washed away. Rounded stones and cobblestones usually cover much of the surface, and small areas with basalt rock outcrops are included on the hillsides.

The grazing value is low. Grazing should be restricted to prevent further damage by erosion and to allow an increase in the density of forage plants.

Hibbard clay loam (0–12% slopes) (Hm).—This soil occurs on gently sloping, sloping, nearly level or slightly depressed alluvial fans. The parent material is mostly of argillitic origin but some of it is from basalt, granite, quartzite, and other kinds of rock. Slopes are dominantly in the 5- to 10-percent range, though the total range is 0 to 12 percent. Some areas are dissected by small ravines. Surface drainage is slow to medium, and internal drainage is slow. The soil is slowly permeable to roots and water and its water-holding capacity is good. The surface soil is nearly free of stones and has a fair content of organic matter. The natural vegetation is grass, sagebrush, serviceberry, other shrubs and flowering plants, and in places a few ponderosa pines and aspens.

Profile description.—To a depth of 6 inches the surface soil is dark grayish-brown friable clay loam that is very dark brown when moist. This material is somewhat granular in virgin areas, noncalcareous, and neutral or slightly acid in reaction. Between depths of 6 and 12 inches the lower surface soil is similarly or slightly lighter colored gritty clay

loam that breaks with a faint vertical cleavage into easily crumbled aggregates. It is slightly firm but not compact.

The upper subsoil from a depth of 12 to 28 inches is brown or grayish-brown compact clay, clay loam, or heavy clay loam. This material breaks with a faint vertical cleavage into hard aggregates the size of a nut or smaller. It is noncalcareous and neutral or slightly acid.

Between depths of 28 and 50 inches the subsoil is light yellowish brown firm clay loam that breaks into angular fragments faintly variegated with grayish brown and some specks of rust brown. This material is calcareous in most places.

A few pebbles generally are in the surface soil and subsoil. Below a depth of 4 feet the lower substrata generally show some of the original layers of the parent material. Distinctly stratified beds of yellowish-brown and pale-brown gravel, gravelly loam, cobblestones, and some fine material lie below an average depth of 6 feet. The depth to coarse gravel ranges from 4 to 8 feet or more.

Included with this soil are small areas in the locality of Lower Powder Valley with a somewhat different profile. Here the soil is dark-gray somewhat granular neutral clay loam to an average depth of 12 inches. Below this is dark grayish-brown noncalcareous compact plastic clay containing some imbedded gravel. Below a depth of about 26 inches is a 2-foot layer of soft hardpan consisting of light-gray and very pale-brown more or less calcareous weakly cemented loamy interstitial material and subangular pebbles. Below the hardpan is light-gray or very pale brown calcareous gravelly clay loam. The relief of this variation is nearly level or slightly depressed, and its surface runoff and internal drainage are slow though adequate for most crops. Yields on it are slightly lower than on areas of Hibbard clay loam in Baker Valley.

Use and management.—Hibbard clay loam is used mainly for native pasture, but small areas are utilized for grain and hay crops. The soil has undergone some erosion and seems rather susceptible to gullying. Small gullies are rather common, but most of them have been made in prospecting for gold.

Hibbard clay loam, eroded phase (2–12% slopes) (HN).—This phase has been moderately to severely eroded. Much of the surface soil—25 percent or more in most places—has been lost because of accelerated erosion, and many areas are gullied. The present eroded condition increases runoff and susceptibility to further erosion. Except for erosion, the soil closely resembles Hibbard clay loam.

Most of this phase is used for grazing, but its suitability has been reduced by erosion. Grazing should be carefully controlled so that the vegetative cover may increase and prevent further damage.

HUTCHINSON SERIES

Soils of the Hutchinson series occur on old alluvial fans and terraces. They formed under sagebrush and grass where the annual precipitation is 11 to 14 inches and are associated with the Baker, Virtue, Bulger, and Ladd soils. Hutchinson soils differ from those of the Baker and Virtue series in having mainly a noncalcareous subsoil more compact than that of the Baker and less compact than that of the Virtue. They are not so stony nor so compact as the Salisbury soils.

Hutchinson loam (3–7% slopes) (Hx).—This grayish-brown well-drained soil has a fairly strongly developed subsoil containing little or no lime. It developed from old alluvium derived largely from granite or other rock material high in content of quartz. In places the upper part of the soil may have formed from or been influenced by wind-deposited silty material. This soil occurs on high slightly dissected alluvial fans and terraces, generally on undulating relief. On the upper part of the fans it is bordered in places by Kilmerque soils, but at lower elevations it generally merges with soils of the Baker, Onyx, Bulger, or Virtue series. The subsoil is generally more alkaline at the lower elevations.

The soil contains a few stones but not enough to interfere with cultivation. It is free of alkali and excess soluble salts. Surface drainage is slow to medium and the water-holding capacity is good because of the deep friable surface soil. The subsoil is compact and very slowly permeable to water and roots. Uncleared areas are covered with a heavy growth of sagebrush and grass, some rabbitbrush and other shrubs, and a large number of flowering plants.

Profile description.—To a depth of 8 inches the surface soil is grayish-brown to slightly dark grayish-brown friable loam or silt loam. It is very dark brown or dark grayish-brown when moist. This material has a moderate content of organic matter and it contains a trace of mica, some granitic grit, and much very fine sand. It passes into a similarly colored friable loam that shows faint vertical breakage. There are many fine roots in these surface layers and a few rounded stones and pebbles on the top of the ground. In total depth, the surface soil ranges from 6 to 36 inches.

At an average depth of 18 inches the surface soil is abruptly replaced by brown or slightly reddish-brown tough compact heavy clay loam or clay containing some pebbles. This material has a prismatic structure and breaks into elongated aggregates 1 or 2 inches across that are hard to crumble. This heavy tough layer is on the average 12 inches thick. Where it is thicker it is generally less tough and less compact.

At an average depth of 30 inches the soil is a variegated light reddish-brown, pink, yellowish-brown, and rust-brown, very compact weakly or softly cemented gravelly loam containing many cobblestones. This material ranges from a cemented hardpan of gravelly clay loam to a compact sandy loam. Like the horizons above, this material is neutral or mildly alkaline and typically noncalcareous. A few fine roots are present at this depth.

The soil material becomes less compact with depth. At about 40 inches it passes into compact very pale-brown or light yellowish-brown gravelly loam or gravelly sandy loam in which there are many rounded and subangular cobblestones. Following at a depth of about 50 inches is very pale-brown or light yellowish-brown less compact gravelly loam or gravelly sandy loam. The lower part of this layer typically is noncalcareous, although in places there is a thin calcareous layer. The layers above this less compact one offer much resistance to a crowbar. The substrata below a depth of 6 feet consist of irregularly stratified layers of coarse and fine-textured old alluvium, mostly of granitic origin. A thin layer of light-gray pumice and volcanic ash occurs in the subsoil in places.

Use and management.—Probably 60 percent of Hutchinson loam is under cultivation. Wheat and alfalfa are the main crops. The wheat is grown mainly on dry farms. The Turkey and Baart varieties are grown on dry farms, and the Federation variety under irrigation. This is considered a moderately productive soil.

The smooth relief has retarded erosion in most places, but sloping areas show considerable soil loss. In order to control erosion, slopes of over 4 percent should be cultivated on the contour.

Hutchinson loam, shallow phase (5–15% slopes) (Hʏ).—This phase differs from Hutchinson loam mainly in having a shallower and stonier surface soil, steeper slopes, and more erosion. It lies on sloping somewhat dissected alluvial fans of undulating to gently rolling relief. Most of the slopes range from 5 to 10 percent. Surface drainage is medium to rapid. The soil has a fair water-holding capacity, but underdrainage is restricted by the subsoil, which is very slowly permeable. A heavy growth of sagebrush and grass covers uncleared areas.

Profile description.—The surface soil, about 6 inches thick, is a grayish-brown or slightly dark grayish-brown friable loam containing a variable quantity of rounded and subangular pebbles and cobblestones. The coarse material is largely biotite-quartz diorite, a coarsely crystalline rock, but some basalt, argillite, and other kinds of rock are included. The surface soil is moderate in organic content and grades into grayish-brown loam that breaks into subangular easily crumbled fragments.

The upper subsoil between depths of 12 and 30 inches is brown or slightly reddish brown tough compact heavy clay loam or clay containing many rounded and subangular cobblestones and pebbles. This material has an indistinct prismatic structure, breaks into large irregular aggregates that are hard to crumble, and is difficult to penetrate with a crowbar.

Abruptly replacing the above layer is variegated light yellowish-brown, rust-brown, and very pale-brown cemented gravelly sandy loam or gravelly loam in which there are many rounded cobblestones. The consistence of this material varies at different depths from moderately compact to weakly cemented hardpan. It is less compact with depth and at about 50 inches passes into stratified layers of light yellowish-brown coarse alluvium and brown heavier material. The entire soil is mildly alkaline to neutral in reaction and is noncalcareous in most places.

Use and management.—Probably 20 percent of this phase is cultivated. It is used mostly for wheat and alfalfa. Wheat is grown principally on dry farms under a system of summer fallow.

The cultivated areas are nearly all northwest of North Powder. Areas of the soil northwest of the Muddy Creek School are shallower and stonier than typical and of little value for crops. The uncleared areas are used for native pasture, for which they have a better suitability than average.

Most of the fields should be cultivated on the contour to reduce erosion, especially where slopes are more than 5 percent. Overgrazing has caused some sheet erosion. Possibly 25 percent of the surface soil has been lost.

KEATING SERIES

Soils of the Keating series have developed in upland areas on residuum from weathered greenstone bedrock. Natural drainage is good, and internal drainage is medium to slow. The relief is gently sloping to steep. There are few terracelike areas. The native vegetation is sagebrush and grass. In places the Keating soils border the Ruckles and Virtue soils. They are also associated with Clover Creek soils, from which they differ in being noncalcareous. Clover Creek soils are developed on lenses of limestone within the larger masses of greenstone bedrock on which the Keating soils have formed. Keating soils differ from the Brownlee soils in being developed from weathered greenstone rather than granite. Most of the Keating soils are too shallow to permit cultivation.

Keating loam (7–12% slopes) (KA).—Some areas of this rather shallow soil, amounting to perhaps 35 percent of the total, are on slopes of less than 7 percent, and these are used mostly for range land. The soil is well-drained and moderately to slowly permeable to roots and water. The water-holding capacity is fair and is limited by the shallowness to bedrock.

Profile description.—The surface soil extends to a depth of 8 inches and is a brown, dark grayish-brown, or dark-brown neutral, fine, granular gritty loam. This material is very friable, easily crumbled, and very dark brown to very dark grayish brown when wet. Although this layer has many roots, its organic content is moderate to somewhat low.

The upper subsoil, extending from a depth of 8 to 30 inches, is brown or yellowish-brown neutral to mildly alkaline compact gritty clay loam that breaks into large blocks showing irregular vertical or prismatic structure. This layer is hard to penetrate with a crowbar and contains many partly disintegrated greenstone fragments in the lower part.

Between depths of 30 and 40 inches is partly decayed or disintegrating greenstone fragments and brown or yellowish-brown clay loam interstitial material. Owing to the high rock content, this part of the subsoil is hard to penetrate with a crowbar.

Below 40 inches the material is principally dark-gray and yellowish-brown somewhat weathered greenstone. Fine roots penetrate cracks in this rock. Nearly solid dark-gray greenstone bedrock generally lies at a depth of about 50 inches, but the depth may range from 20 to 60 inches or more. The greenstone is hard and weathers slowly.

Scattered small bodies covering about a square mile west of North Powder have a slightly darker surface soil than typical. These areas occur near the foot of the mountains where the rainfall is about 2 or 3 inches higher than the average for this soil.

Use and management.—The native vegetation of sagebrush and grass on Keating loam has a somewhat higher grazing value than average for the area. About 5 percent of the soil is in irrigated alfalfa and wheat, and small areas of these crops are dry-farmed. Some dry-farmed alfalfa is cut for seed and yields about 3 bushels an acre. The soil has sustained moderate sheet erosion following unrestricted grazing. Probably half of the soil has lost as much as 25 percent of the surface soil. There is little gully erosion.

Keating loam, gently sloping phase (0–7% slopes) (KF).—Areas of this phase occur on nearly level, undulating, or gently sloping relief. Owing to the gentle slopes, surface runoff is slower, erosion hazard is less, and tillage and irrigation are easier than on Keating loam. Practically all of this soil is under cultivation. Uses and management practices are rather similar to those employed on cultivated areas of Keating loam.

Keating loam, hilly phase (12–25% slopes) (KG).—This phase differs from Keating loam principally in having strongly sloping or hilly relief. Because of this stronger relief, surface runoff is rapid to very rapid, erosion is more active, and profile characteristics are somewhat more variable. The less favorable relief also makes tillage and irrigation more difficult.

This phase occupies a small total area and is used principally for native range pasture. It is of about average value as grazing land. Only a small area is cultivated, mainly for hay. Yields are similar to or slightly lower than on Keating loam.

Keating loam, eroded hilly phase (12–25% slopes) (KD).—Except for being steeper and moderately or severely eroded, this phase is similar to Keating loam. Shallow gullies occur in places, and here and there the subsoil is exposed. A few slopes are greater than 25 percent.

The total area of this phase is small. It is used principally for pasture. The grazing value is somewhat below average. Grazing should be rather carefully controlled to increase the carrying capacity, and reseeding may be needed on some areas.

Keating loam, eroded steep phase (25–45% slopes) (KE).—This phase differs from Keating loam principally in having steep relief and in being moderately or severely eroded. Surface runoff is very rapid. The soil is more erodible, more variable in depth and other profile characteristics, and generally shallower and more difficult to till and irrigate than Keating loam. The soil is usually deeper than average at the base of slopes. Most areas have lost 25 percent or more of the topsoil through erosion, and some areas are gullied.

This phase, which has a very small total area, is used principally for grazing, but its grazing value is slightly lower than the average for the area. Considerable care is necessary to prevent overgrazing. A few small included areas having slopes of somewhat less than 25 percent are used for alfalfa and wheat.

Keating loam, deep phase (0–5% slopes) (KC).—This phase has a darker surface soil and is deeper to bedrock then Keating loam. It is closely associated with other Keating soils and generally occurs in swales or on foot slopes where it receives some runoff from higher land. The relief is fairly smooth. Surface runoff is slow and underdrainage is adequate. About 5 miles west of North Powder a total of about 400 acres occurs in small areas in association with the Ruckles soils. These areas are near the foot of the mountains where the rainfall is slightly higher.

Profile description.—The surface soil—dark grayish-brown loam of neutral reaction—extends to a depth of 12 inches. It is friable, fine granular, easily crumbled, and very dark brown when wet. Under

virgin conditions the soil is weakly root-bound and contains a fair quantity of organic matter.

The upper subsoil—occurring between depths of 12 and 30 inches—is brown, yellowish-brown, or grayish-brown loam or slightly compact gritty clay loam. This material is mildly alkaline but noncalcareous, is permeable to water and fine roots, and has good water-holding capacity. It breaks into irregular aggregates that crumble fairly easily.

The lower subsoil, extending from a depth of 30 to 60 inches, is brown loam containing more or less weathered greenstone rock fragments. It is mildly alkaline and in most places does not contain lime enough to effervesce in dilute hydrochloric acid.

At an average depth of 60 inches there is a mixture of greenstone rock fragments and soil that grades downward into greenstone bedrock at a depth of about 8 feet.

Use and management.—Probably 75 percent of this phase is under cultivation. It is used principally for dry farming and is well suited to that use because of its high water-holding capacity and favorable topographic position. Wheat and alfalfa are grown. Some alfalfa and crested wheatgrass are grown for seed. About 25 percent of the areas west of North Powder are cultivated under irrigation, mainly to alfalfa and wheat. The uncleared areas furnish good range pasture.

Owing to the smooth relief, permeable suboil, and topographic situation there has been little erosion. Deposits of sediment from higher areas occur on many areas.

Keating stony loam (12–25% slopes) (KH).—This soil is associated with others of the Keating series. The relief is hilly. Some gently sloping and sloping areas were included in mapping and are used chiefly as range land along with the rest of the soil. The topography is that of a succession of valleys and rounded hills. The valleys are generally less than 100 feet deep but afford complete drainage. The soil is moderately to slowly permeable to moisture but the water-holding capacity is low because of the shallow depth to rock. There are a few rock outcrops. The surface soil and upper subsoil are both noncalcareous. The natural vegetation is sagebrush, the common grasses of the area, and a few scattered bitterbrush, mountain-mahogany, rabbitbrush, and other shrubs and flowering plants.

Profile description.—The surface soil is brown or dark grayish-brown somewhat granular stony loam containing much partly disintegrated rock.

The upper subsoil, occurring between depths of 6 and 12 inches, is brown, pale-brown, or yellowish-brown gritty clay loam containing many angular rock fragments. The material is irregularly prismatic, compact, and hard to penetrate. Between depths of 12 and 24 inches the subsoil is similarly colored loam or clay loam containing many rock fragments. The stoniness increases with depth. This material is neutral or mildly alkaline, compact, and hard to penetrate with a bar because of its high content of stones. The layer below 24 inches is principally greenstone having a small quantity of loam between the rocks. The subsoil layers are conspicuously redder at higher altitudes, where precipitation is greater. This deeper color is particularly evident where this soil borders those of the Mehlhorn series.

The parent rock is mixed rust-brown, brown, dark-gray, and gray-green greenstone. Below 36 inches the greenstone is little weathered and extremely hard to break, even with a drill. It is noncalcareous and generally mildly alkaline. Some fine roots go into cracks in the rocks.

Use and management.—Practically all of Keating stony loam is used for range pasture. The grazing value is about average for the area. Much of the soil has lost 25 percent or more of the surface soil through erosion that followed overgrazing.

Keating stony loam, eroded phase (12–25% slopes) (KE).—Severely eroded or gullied areas with slopes of less than 25 percent make up this phase. It is similar to Keating stony loam, but the surface soil is shallower and more irregular in depth. The subsoil is exposed in places, and shallow gullies are rather common. There are only a few deep gullies because the soil is shallow to bedrock.

This soil is used for range pasture but has a rather low grazing value. Grazing should be controlled to prevent further erosion by allowing increase in the density of the vegetative cover.

Keating stony loam, gently sloping phase (0–7% slopes) (KM).—Except for the smoother relief, this phase is similar to Keating stony loam. Although this phase was cultivated at one time, it is poorly suited to farming because it is shallow and stony. Most of it has been abandoned and is now in pasture.

Keating stony loam, sloping phase (7–12% slopes) (KN).—This phase is similar to Keating stony loam in most features except its gently rolling or sloping relief. Rock outcrops are less common. The soil occurs on rounded tops of hills and ridges, and because of its smoother relief, it is less susceptible to erosion and has a slightly higher grazing value than Keating stony loam. It is used chiefly for pasture.

Keating stony loam, steep phase (25–45% slopes) (Ko).—The soil and its cover, origin, and land use are rather similar to Keating stony loam. Rock outcrops are somewhat more common, relief is steeper, and the grazing value is slightly lower. None of this soil is cultivated.

Keating stony loam, eroded steep phase (25–45% slopes) (KL).—Severely eroded or gullied areas with dominant slopes of more than 25 percent are mapped in this phase, which is similar to Keating stony loam but has a shallower surface soil. The subsoil is exposed in places, and shallow gullies are fairly common. Many stones are scattered over the surface, and rock outcrops, indicated on the soil map by rock-outcrop symbols, occur in many places. The soil occurs mostly along streams and V-shaped ravines that extend into rounded hills. It is used for range pasture but provides scant grazing. Its use should be drastically reduced in order to prevent further damage by erosion and to give the range a chance to recuperate.

KILMERQUE SERIES

Soils of the Kilmerque series have formed under a cover of ponderosa pine and other trees from biotite-quartz diorite, a coarsely crystalline rock. The most typical areas overlie bedrock, but some areas that overlie colluvial material on foot slopes are included. In places the upper part of the soils, particularly of the loam type, may be

derived from wind-deposited silts. Relief ranges from gently sloping to steep. The soils are generally bordered by those of the Ladd series on the lower sides and by Rough broken and stony land above.

The Kilmerque soils developed from material similar to that of the North Powder soils but under a forest cover rather than one of sagebrush and grass; furthermore, they have a noncalcareous rather than a calcareous lower subsoil. They resemble the Moscow soils, but those soils have a more compact subsoil and are developed on residuum from albite granite, a more acidic rock than biotite-quartz diorite.

Kilmerque loam (5–15% slopes) (Kp).—The relief of this well-drained forest-covered soil of the uplands is mostly gently rolling. The soil is moderately permeable, and roots penetrate to a depth of 6 feet. Its water-holding capacity is good. Some diorite stones are scattered over the surface and throughout the soil, but they do not occur in quantities sufficient to prevent cultivation. The native vegetation is mostly ponderosa pine but includes some western larch (tamarack), white fir, cedar, Douglas-fir, mountain-mahogany, willows, and other trees and shrubs. The original timber has been removed, but the uncleared areas have a young growth of trees.

Profile description.—The surface soil in virgin areas has a covering of 1 to 2 inches of very strongly acid more or less decayed organic material. Below this the soil consists of grayish-brown or dark grayish-brown friable loam. The upper part is strongly acid and fluffy and slightly darker, and the lower part is medium or slightly acid and crushes into soft aggregates and then into single grains or fine crumbs. There are many roots, but the organic content is lower. The material in this layer ranges from a medium to coarse loam and contains much sharp sand and mica.

At a depth of about 8 inches the material passes into pale-brown, light yellowish-brown, or very pale-brown friable slightly or medium acid loam that breaks into soft subangular easily crumbled aggregates. Between depths of 15 and 35 inches the subsoil is similarly colored slightly or medium acid or neutral micaceous firm or very slightly compact heavy loam that breaks into irregularly shaped subangular easily crumbled aggregates. This material is faintly variegated with rust brown, and in the lower part contains much disintegrated biotite-quartz diorite.

From a depth of 35 to 60 inches the material is similarly colored slightly acid or neutral slightly compact heavy loam showing rust brown and brown staining. It contains many sharp partly disintegrated rock fragments.

The underlying bedrock (biotite-quartz diorite) is at an average depth of 50 inches. On some of the lower slopes the underlying material is talus and colluvial, but in all locations this part of the profile consists of crystalline material containing much biotite. The bedrock is noncalcareous and neutral in reaction.

Use and management.—About 25 percent of Kilmerque loam has been cleared and is now under irrigation. The main crops are alfalfa and wheat. Uncleared areas have undergone very little erosion. The cultivated fields lose some soil through sheet erosion when the frost goes out in spring. Some cultivated areas have lost as much as 25 percent of the surface soil since they were cleared.

Kilmerque loam, hilly phase (15–30% slopes) (KR).—Steeper in relief than Kilmerque loam, this phase occurs largely along V-shaped valleys and on breaks below benchlike areas. The soil is more variable in depth, shallower, and stonier than Kilmerque loam. None of it is cultivated, but small areas have been partly cleared for pasture. This soil washes easily where cleared and should be used only for production of timber. The total area is small.

Kilmerque sandy loam (2–15% slopes) (KS).—The forest cover under which this soil formed consisted principally of ponderosa pine but included many western larch (tamarack), Douglas-fir, white fir, and other trees. Most of the forest now is second growth. The parent material is mostly residual from the underlying bedrock but it includes some foot slope and colluvial material. Relief is usually rolling. The soil is permeable, and roots go down to a depth of 6 feet or more. The water-holding capacity is low. A few stones are scattered over the surface and throughout the soil. The depth to bedrock varies greatly in short distances, and there is a corresponding variation in thickness of soil layers.

Profile description.—In virgin areas the soil has a 1- to 2-inch surface covering of organic material. The upper part, consisting of loose needles of ponderosa pine, tamarack, and fir and other forest litter, grades into dark grayish-brown strongly or very strongly acid decayed pine needles, bark, and twigs containing some white threadlike materials from molds. This overlies about an inch of dark grayish-brown or grayish-brown strongly or very strongly acid fluffy sandy loam containing much organic material. In places a very thin light-gray layer is found just below the organic layer. The surface soil below this is grayish-brown medium or slightly acid micaceous sandy loam that contains much coarse sand. It is very dark brown to very dark grayish-brown when moist. Although there are many roots the organic content apparently is low to moderate.

The subsoil, beginning at a depth of about 8 inches, is pale-brown or light yellowish-brown friable sandy loam containing much sharp sand and many fine roots. This layer is slightly or medium acid. From 20 to 40 inches the subsoil is light yellowish-brown or very pale-brown friable micaceous coarse sandy loam containing much disintegrated biotite-quartz diorite. This material breaks into small easily crumbled nut- and pea-sized aggregates, contains many fine roots, and is slightly acid or neutral in reaction. The content of rock increases with depth.

From a depth of 40 to 70 inches the material is partly disintegrated rock fragments similar to the layer just above in color. Below an average depth of 70 inches the rock is hard and slightly weathered.

Use and management.—Kilmerque sandy loam is used mostly for woodland and the production of timber. These are the uses to which it is best suited. Some of the land is grazed for a short time during the summer, but the grazing value is low. Erosion has been very slight because the timber growth has afforded excellent protection. The soil is naturally porous and somewhat droughty and is not very productive. About 5 percent is under cultivation. Rye is the main crop under dry farming. Small areas have been cleared for pastures.

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Kilmerque sandy loam, hilly phase (15–30% slopes) (Kv).—This phase differs from Kilmerque sandy loam principally in being more hilly. It occurs mainly along timbered V-shaped ravines. It supplies a small amount of grazing during the summer but is best used for production of timber or as source of the farm wood supply.

Kilmerque sandy loam, eroded steep phase (25–45% slopes) (Ku).—This phase is similar to Kilmerque sandy loam, hilly phase, but somewhat steeper and more generally affected by erosion. It occurs principally along V-shaped valleys cut in domelike ridges. The relief is rugged, or semimountainous, and the soil is shallow and irregular in depth.

Overgrazing and removal of timber have resulted in some sheet erosion, but the damage is not particularly severe. The soil is used for pasture but is better suited to the production of timber.

LADD SERIES

Soils of the Ladd series are developed on well-drained slightly dissected old alluvial fans and terraces under a cover of grass and sagebrush and an annual precipitation of 15 to 19 inches. The alluvial parent material is largely of granite or dioritic origin. In places the upper part of the soil may be influenced by or derived from wind-deposited silty or loesslike material. Ladd soils resembles the Hutchinson but have a darker surface soil.

Ladd loam (3–10% slopes) (La).—The rather smooth relief of this dark soil is typical of high slightly dissected old alluvial fans and terraces. Profile layers are fairly prominent. The surface soil is somewhat free of gravel in all areas except those marked on the map with gravel symbols, and it is fairly high in organic-matter content. The subsoil is slowly permeable to roots and water. The soil contains no soluble salts or alkali and has good water-holding capacity.

Profile description.—The surface soil, to a depth of about 5 inches, is dark-gray or dark grayish-brown granular friable heavy gritty loam. This material is black or very dark gray when wet, sod-bound and easily crumbled in virgin areas, and nearly neutral in reaction. It grades into heavy loam of similar color that breaks into angular aggregates and contains many roots.

The upper subsoil, between depths of 10 and 20 inches, is brown tough compact clay or clay loam of distinct prismatic structure. When dry this layer is hard to penetrate with a crowbar and it breaks into small prisms. Most of the roots follow fissure planes but some penetrate the dense aggregates. The color varies from brown to yellowish brown or grayish brown. The lower subsoil, between 20 and 36 inches, is light yellowish-brown, pale-brown, or very pale-brown compact gritty clay loam.

The depth to the light-gray, very pale-brown, or yellow irregularly stratified cobbly, gravelly, or sandy substratum ranges from 20 to 60 inches or more, and there is a corresponding range in the thickness of the layers above. Most of the cobblestones and pebbles are rounded or subangular and considerably weathered. They consist mostly of biotite-quartz diorite.

As a rule the subsoil and substratum are noncalcareous, but some areas that have a calcareous lower subsoil are included because they are too small to delineate separately on a map of the scale used. Also

included are some areas having a more gravelly surface soil than normal. These more gravelly areas usually have the gravelly substratum at a shallower depth.

Use and management.—About 80 percent of Ladd loam is cultivated; part of this is under irrigation but most of it is dry-farmed. Wheat is the main crop. Federation wheat is the principal variety on irrigated land, and Turkey or Baart wheat on dry-farmed areas. Some oats and rye are grown. No commercial fertilizer and little manure are used on this soil. There has been some sheet erosion but little gully erosion. The uncleared areas are used for native pasture.

Ladd loam, deep phase (3–10% slopes) (Lc).—A less compact upper subsoil and a somewhat greater depth to the gravelly substratum differentiate this phase from Ladd loam. Relief is smooth (pl. 4, *A*). Surface drainage is slow to medium and internal drainage is medium to slow. This soil is closely associated with Ladd loam. Its surface soil and subsoil contain a small quantity of gravel but very few stones. The subsoil is moderately to slowly permeable to roots and water and has a good water-holding capacity.

Profile description.—The surface soil—dark gray or dark grayish-brown friable granular silt loam or loam—has a fairly high content of organic matter and goes down to a depth of about 10 inches. In virgin areas the upper part is sod-bound. The lower part breaks into small easily crumbled aggregates and is black or very dark gray when moist. It passes into grayish-brown friable silt loam or heavy loam.

The subsoil has two layers. The upper part, between 15 and 30 inches, is generally brown to pale-brown tough compact heavy clay loam that breaks along vertical cleavage planes into large aggregates containing many fine holes left by old root channels. The material has a slight reddish-brown tinge in cut banks but is more yellowish when crushed. The lower subsoil, between depths of 30 and 50 inches, is of variable texture and color. It ranges from brown to pale brown to yellowish brown and from clay loam to rather compact loam.

More or less stratified coarse granitic or dioritic material usually begins at 50 inches, but it may occur at any depth between 30 and 80 inches or more. In places a hardpan layer may be at any depth from 30 to 60 inches.

There is some variation in the profile. The lower subsoil is noncalcareous in the western part of Baker Valley where this soil borders Hutchinson loam, but it is calcareous farther east where the soil borders Baker silt loam. Farther east the soil differs from Baker silt loam mainly in having a darker surface layer.

Use and management.—About 90 percent of this phase, is cultivated, mostly under irrigation. Wheat and alfalfa, the principal crops, yield about the same as or slightly more than on Ladd loam. Owing to the smooth relief, erosion has been slight.

Ladd loam, alluvial-fan phase (3–15% slopes) (Lb).—This phase is not typical of the Ladd series but should be considered as a variant of the series. It differs from Ladd loam principally in occurring on somewhat more recent alluvial fans and in having a less strongly developed textural and structural profile. The subsoil is less compact, dense, and heavy but more permeable than that of Ladd loam. Wind-deposited silts may have contributed to the upper part of the soil. Dominant slopes range from 3 to 8 percent.

Except in those areas indicated on the soil map by stone symbols, the surface soil is rather free of stones and pebbles. The subsoil is moderately to slowly permeable and has good water-holding capacity. The parent material is mostly from biotite-quartz diorite, a highly crystalline rock. Surface drainage is slow to medium and underdrainage is good. The soil is free of soluble salts and alkali.

Profile description.—To an average depth of 15 inches the surface soil is grayish-brown to dark-gray friable loam or silt loam that becomes very dark brown when moist. The material breaks into more or less granular nut- or pea-sized aggregates and is slightly to medium acid. In virgin areas the surface soil is sod-bound to a depth of about 10 inches and fairly high in content of organic matter. The total depth of the surface soil is variable. Part of this variation undoubtedly can be attributed to wind deposition of silty material. Material may have been blown from some places and deposited in others.

The soil between average depths of 15 and 20 inches is slightly lighter colored, neutral or slightly acid, friable loam or silt loam that breaks into small easily crumbled aggregates. Like the material in the rest of the profile, it is noncalcareous and contains much mica.

The subsoil between 20 and 40 inches is pale-brown or yellowish-brown slightly compact or firm gritty heavy loam. This material breaks into nutlike aggregates that generally have faint grayish-brown coatings. There are many fine roots.

The lower subsoil between 40 and 60 inches is pale-brown or light yellowish-brown gritty heavy loam containing some partly decomposed granitic or dioritic material. It shows some stratification and in places includes thin layers of clay loam and sandy loam.

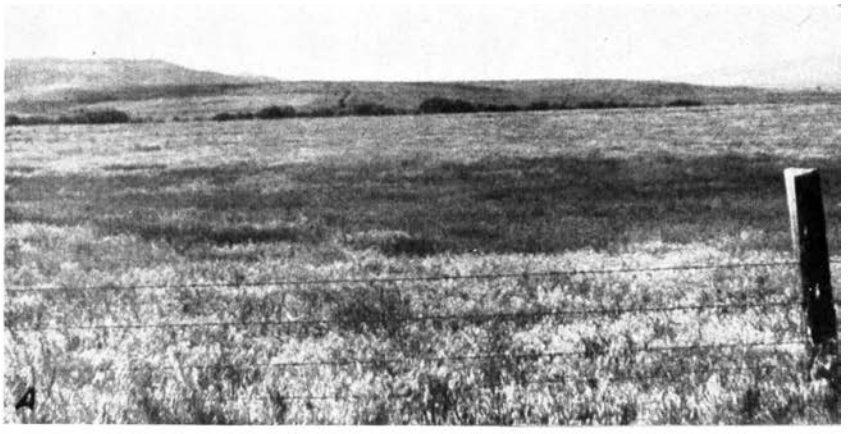
The substratum consists of partly assorted or irregularly stratified light yellowish-brown gravel, cobblestones, small stones, and fine interstitial materials. It begins at an average depth of 60 inches but may occur at any depth between 30 inches and 8 feet or more. This deposit of assorted material is progressively thinner near the western border of the soil, where the old alluvial material grades into residual granite. The layers of the substratum are noncalcareous and nearly neutral in reaction.

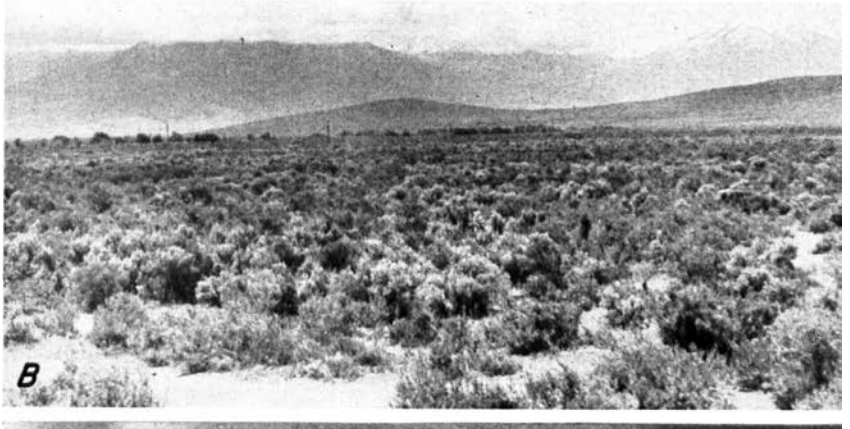
Use and management.—Probably 90 percent of this phase is cultivated. About half of the cultivated area is in alfalfa. Wheat is grown on about 30 percent of the cultivated areas. Barley and oats are also grown. This phase is one of the best soils for fruit in the Baker Valley. Apples, pears, peaches, strawberries, and cane fruits are grown for home use and produce good yields.

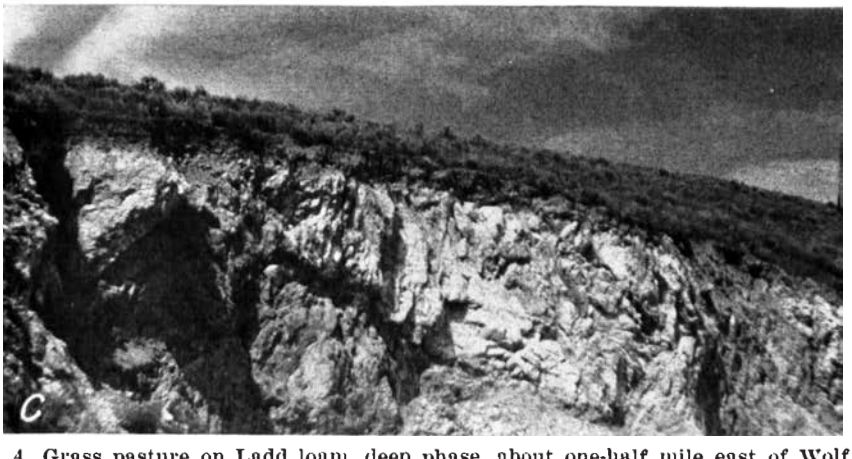
Erosion caused by irrigation has been slight because the soil is permeable and fairly gently sloping and has been in hay crops or grains most of the time.

Ladd loam, hilly phase (15–30% slopes) (Ld).—More recent alluvial fans are occupied by this phase, which is a variant of the Ladd series and is not typical. The soil is essentially similar to Ladd loam, alluvial fan phase, but is shallower and stonier. The cover of waterlaid material over the diorite or granite bedrock is thinner, and the bedrock comes within 4 feet of the surface in places. The natural vegetation is grass, shrubs, and locally a few scattered ponderosa pines.

Use and management.—About 50 percent of this phase is cleared and in part irrigated. Alfalfa and cultivated grasses, the principal



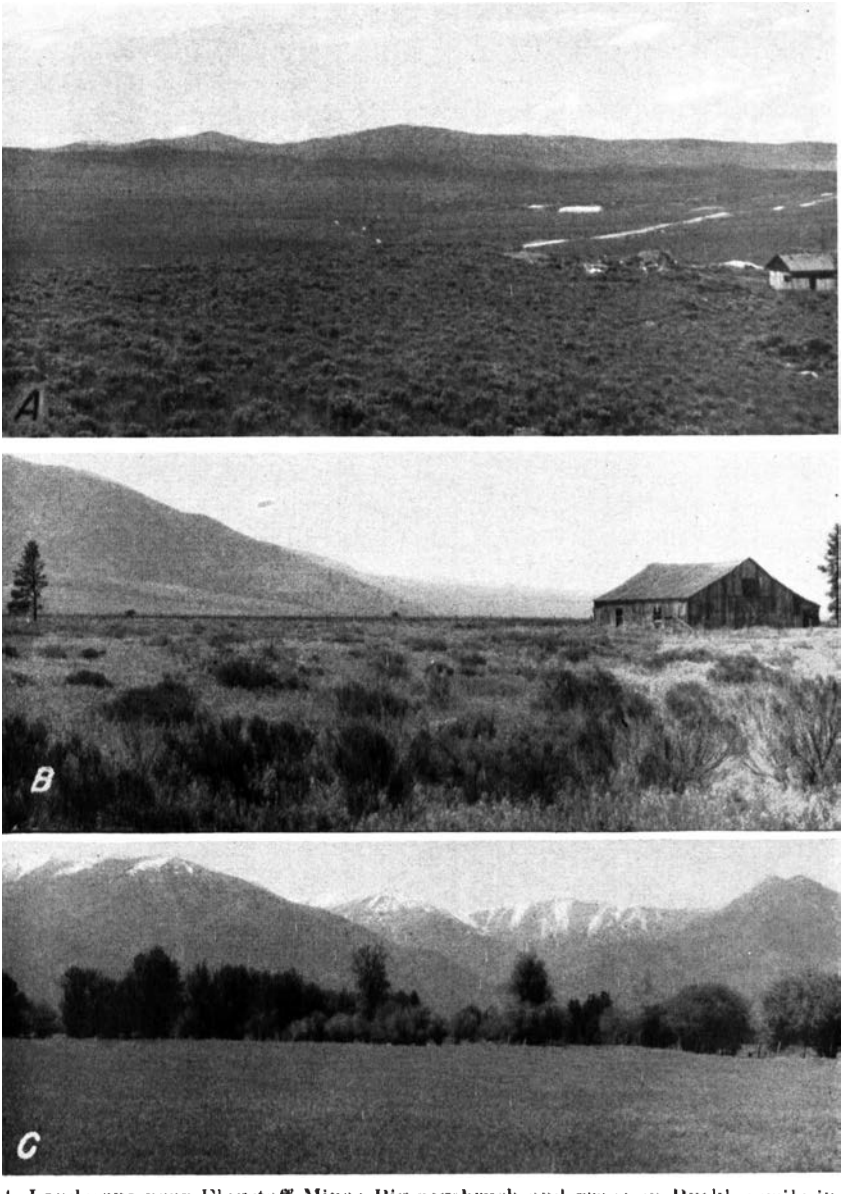




A, Grass pasture on Ladd loam, deep phase, about one-half mile east of Wolf Creek School.

B, Greasewood, sagebrush, and saltgrass on Lun silt loam, Blue Mountains in distance.

C, Cut in North Powder loam northeast of Baker; soil has an accumulation of lime just above the biotite-quartz diorite bedrock. Natural vegetation is mainly big sagebrush and grass.



A, Landscape near Flagstaff Mine: Big sagebrush and grass on Ruckles soils in foreground; mostly Virtue silt loam in middle distance.

B, Big sagebrush, grass, and scattered ponderosa pine on Springdale fine sandy loam and Springdale gravelly sandy loam.

C, Springdale very fine sandy loam about three-fourths mile north of Pocahontas School. Blue Mountains in background.

crops, are used largely for pasture, but small areas are sometimes cut for hay. Where irrigated, the soil is good pasture but is subject to erosion. Occasional shallow gullies caused by irrigation occur in cleared areas.

LANGRELL SERIES

Soils of the Langrell series are friable, well-drained, and noncalcareous. They developed on fairly recent, or young, alluvial fans under a cover of grass, shrubs, and scattered trees and an annual precipitation of 17 to 25 inches, including snow. The relief is smooth and representative of that found on gently sloping fans and low terraces. The parent material is water-laid and comes largely from granite, basalt, greenstone, lava and other metamorphic rocks.

Langrell gravelly loam (1–3% slopes) (LE).—This soil is closely associated with Langrell loam and the Halfway soils. Its surface layer is high in content of organic matter and contains enough gravel to interfere with but not prevent cultivation. In virgin areas there are some small stones, but most of these have been removed from cultivated tracts. The surface soil is moderately to rapidly permeable. Roots, water, and air penetrate readily. Surface drainage is slow and underdrainage is good. The water-holding capacity is low.

Profile description.—The surface soil is dark grayish-brown slightly acid or neutral gravelly loam that extends to a depth of about 8 inches. The upper subsoil, between 8 and 20 inches, is brown or dark-brown slightly acid or neutral friable gravelly loam grading to gravelly clay loam. This layer breaks into nut-sized aggregates that crumble into pea-sized aggregates. Like the rest of the profile, it is noncalcareous.

Between 20 and 30 inches the subsoil is brown or dark yellowish-brown slightly compact gravelly clay loam containing many cobblestones. The cobblestones generally are 2 to 4 inches in diameter but some are as large as 8 inches. Below 30 inches this material is abruptly replaced by irregularly stratified loose porous beds of yellowish-brown cobblestones, gravel, sand, and gravelly loam.

Included with this soil and shown on the map by stone symbols are areas totaling about 1,000 acres in Pine Valley and approximately 600 acres in other places that have sufficient stones and cobblestones to interfere seriously with cultivation. In these areas many rounded or subangular cobblestones and stones, 2 to 8 inches in diameter and mainly granite, are on or in the surface soil. The subsoil of these areas also contains more cobblestones and stones, and the depth to the irregularly stratified gravelly substrata ranges from 12 to 48 inches.

These stony included areas are lower than other Langrell soils and occur mainly on low terraces or flood plains along streams. A narrow belt of trees occurs on the stream banks. Some of the areas may be inundated by early spring floods, but drainage is generally adequate. Internal drainage is medium to rapid except in a few areas having a moderately high water table. Those areas with the higher water table occur at lower elevation than usual and are better for grazing because the water table subirrigates the soil.

Use and management.—Excluding the stony areas, probably 90 percent of Langrell gravelly loam is cultivated. Diversified farming is practiced, and the most common crops are alfalfa, wheat, oats, clover,

orchard grass, and corn. The greatest problem on this soil has been the conservation of irrigation water. Much water seeps away in the porous subsoil. Owing to the smooth relief and porous nature of this soil, there has been little accelerated erosion. It is protected from wind erosion by snow in winter and by crops in summer.

Practically none of the included stony areas are cultivated. Small plots have been partly cleared for building lots, home gardens, and orchards, but approximately 50 tons of rock an acre must be removed for orchards, and more for cultivated crops. The stony areas are used mostly for native bluegrass pasture and they are moderately well suited to such use. About 1 acre will provide one cow with 7 months of summer pasture. In places some of the loose surface stones have been removed to improve the pasture. Outside of Pine Valley the stony areas provide good pasture because they are subirrigated. Generally, areas near the inner curve of stream meanders are very porous and provide poor pasture. An area east of Keating is too high for subirrigation and has a low grazing value. Areas about 2 miles east of McEwen and 1 mile northwest of Halfway have a somewhat coarser textured material that approaches riverwash in characteristics.

Langrell loam (1–3% slopes) (LF).—This is one of the more desirable farming soils of the area. It occupies very gently sloping alluvial fans and is associated with the Halfway soils and Langrell gravelly loam. It is moderately permeable to roots and water and has fair to good water-holding capacity. Surface drainage is slow and underdrainage is good. The surface soil has a fairly high content of organic matter.

Profile description.—The surface soil—dark or very dark grayish-brown or dark-gray slightly acid or neutral friable loam—extends to 12 inches. It is black when moist, and the upper 5 inches is root-bound in virgin areas. This layer is rather free of stones and gravel. It breaks into small, easily crumbled, granular aggregates, and like the rest of the profile, it is noncalcareous.

The horizon between depths of 12 and 20 inches is dark grayish-brown heavy loam or silt loam. It breaks with faint vertical cleavage into small easily crumbled pea- or shot-sized aggregates. A small quantity of gravel is generally present in the lower part of this layer.

The subsoil between 20 and 36 inches is yellowish-brown or brown heavy loam containing much gravel. This material is faintly variegated with grayish brown and rust brown. Below 36 inches are beds of partly assorted yellowish-brown gravel, sand, and cobblestones. The cobblestones are mostly granite but some are basalt or other rock. They range from 2 to 4 inches in diameter for the most part, but some are as large as 8 inches. The depth to the gravelly substrata ranges from 18 inches to 48 inches or more.

Use and management.—Practically all of Langrell loam is cultivated under irrigation. Alfalfa is grown on the largest acreage. Some orchard grass is mixed with the alfalfa, and it thrives well in Pine Valley. Wheat, barley, corn, and oats are grown under irrigation. This soil is especially well suited to truck crops and potatoes. Owing to its smooth relief and permeable subsoil, erosion has been slight.

LOOKOUT SERIES

Soils of the Lookout series developed on dissected sloping lava benches in upland areas. They are typically fine-textured, but many are stony. They differ from the Ruckles soils in having a stronger differentiation of profile layers and more lime in the lower subsoil, in being developed entirely from weathered basalt or andesite instead of a variety of rock materials, and in being slightly browner. The most typical areas occur where the annual rainfall is 9 to 12 inches. Surface drainage is medium to rapid. The native vegetation is sagebrush and grass. A hardpan occurs below a depth of about 20 inches. It is well defined on smooth areas but not so strongly developed in rolling areas. There may be a trace of soluble salts in the hardpan but not a quantity injurious to crops.

Lookout clay loam (5–12% slopes) (LG).—The parent material (*9*) of this soil is mostly weathered basalt or andesite bedrock but it includes some foot-slope and colluvial material. The soil has developed under a low annual rainfall. Surface drainage is medium and water-holding capacity is good. Internal drainage is very slow. The soil does not have an excess of soluble salts but contains a moderately to strongly alkaline hardpan. The natural vegetation includes Sandberg bluegrass, cheatgrass, big bunchgrass, wild barley, needle-and-thread grass, and Indian ricegrass, but sagebrush predominates. Cheatgrass is the most common grass on many heavily grazed areas. This soil is closely associated with the Barnard soils in Eagle Valley, and may include small areas of these soils in that locality. It commonly occurs just below a belt of Mehlhorn soils in other parts of the area. It is rather extensive in the eastern part of the area.

Profile description.—The surface soil is about 9 inches of pale-brown or brown clay loam that crushes into small nut-size fragments that crumble into granules of shot size. When moist it is brown, dark brown, or dark grayish brown; it is sticky and somewhat plastic when wet. The reaction is mildly alkaline, but the material is noncalcareous. A surface layer about 3 inches thick is slightly darker and crumbles more easily than the soil below it.

The upper subsoil, from about 9 to 18 inches, is brown, light-brown, or grayish-brown faintly prismatic clay or heavy clay loam that contains many stones and breaks on vertical planes into irregular angular aggregates. The upper part is noncalcareous, but some specks of lime are in the lower part. This material passes into brown, light-brown or very pale-brown gritty stony clay loam containing much white or pinkish-white segregated lime. It is compact and breaks into angular aggregates.

At depths ranging from 20 to 30 inches the material abruptly passes into a light-gray, white, pinkish-white, and very pale-brown calcareous hardpan, generally more than 2 feet thick. The hardpan contains angular rock fragments cemented together with lime and is difficult to break with a crowbar. Water penetrates very slowly, and plant roots scarcely at all. The content of rock fragments increases with depth below the hardpan, and the material grades into dark-gray or very dark-gray hard basalt or andesite bedrock at a depth of 3 to 6 feet. Exposed rock surfaces are coated with rust brown. Many included areas are gradational between a clay loam and stony clay loam.

Use and management.—About 20 percent of Lookout clay loam in Eagle Valley is under irrigation. The rest is used for native pasture. Much of it is cultivated in order that the abundant water supply in Eagle Valley may be used. Practically none is cultivated elsewhere. Alfalfa is the main crop. Bluegrass is grown on the stonier areas, principally for pasture. Most of the irrigated areas have lost 25 percent or more of the surface soil through sheet erosion and are cut by occasional shallow gullies. Special care should be taken to prevent erosion on irrigated areas because this soil has a fine-textured surface layer and is somewhat shallow to bedrock. The uncleared areas provide better than average grazing.

Lookout clay loam, eroded phase (5–12% slopes) (LK).—Areas of Lookout clay loam that have been appreciably damaged by erosion are mapped as this phase. This phase is similar to Lookout clay loam but its surface soil is shallower and more irregular in depth. More than half of the surface soil has been lost, and shallow gullies are fairly common. Deep gullies are rare because the soil is rather shallow to bedrock.

This phase occurs mostly in small scattered bodies in the eastern part of the area and is of small total extent. It is used only for grazing; its grazing value is slightly lower than the average for the Baker area.

Lookout clay loam, hilly phase (12–25% slopes) (LL).—The profile of this phase is similar to that of Lookout clay loam, but the surface soil is finer textured, the hardpan is thinner and less dense, and the soil is a little browner. Most of this phase occurs on slopes and in ravines below high benches. Surface drainage is rapid to very rapid.

Profile description.—The surface soil, extending to a depth of about 8 inches, is pale-brown or brown clay or heavy clay loam and has many stones scattered over the surface. The upper subsoil is brown or light-brown clay or heavy clay loam containing many rock fragments. It continues to a depth of about 16 inches, where it passes into a weakly cemented calcareous hardpan about 20 inches thick. The hardpan consists of many rock fragments rather weakly cemented by very pale-brown, light-gray, white, and pinkish-white calcareous interstitial material. The content of stones increases with depth. The hardpan grades into weathered basalt or andesite bedrock at a depth of 3 to 6 feet.

Use and management.—About 10 percent of this phase is in irrigated bluegrass pasture, and a small acreage is in alfalfa. Outside of Eagle Valley little of it is cultivated. It is used for range and has a grazing capacity about average for the Baker area. The stand of grass has been damaged by overgrazing.

Lookout clay loam, eroded hilly phase (12–25% slopes) (LH).—Eroded areas of Lookout clay loam, hilly phase, make up this phase. The soil is similar to Lookout clay loam but its surface layer is shallower and more irregular in depth. Over half of the surface soil has been lost through erosion, and shallow gullies are fairly common.

Nearly all of this phase is used for range pasture; an extremely small area is cultivated. The grazing value is much lower than that of Lookout clay loam. Grazing should be carefully controlled to prevent further damage to the range and soil.

Lookout stony clay loam (5–12% slopes) (Lm).—This extensive soil resembles Lookout clay loam but is stonier and shallower and has a less strongly developed hardpan. It developed from residuum weathered from basalt, andesite, or other lava rock. The lava rock is very resistant to erosion and helps to give the soil its structural relief. Surface drainage is medium.

Profile description.—The surface soil—pale-brown or brown noncalcareous mildly alkaline stony clay loam—extends to a depth of about 7 inches. The upper part crumbles to pea-sized aggregates and the lower part to large aggregates. Many stones are on and in the surface soil, and in places the surface is carpeted with rocks.

The upper subsoil, between depths of 7 and 14 inches, is brown, grayish-brown, or light-brown noncalcareous compact stony clay or clay loam. Because much of the material is rock fragments, the structure is rather indefinite or is irregularly prismatic. It passes into brown or light-brown mildly calcareous stony clay loam or clay.

At a depth of about 18 inches, a moderately or strongly alkaline calcareous hardpan about 12 inches thick is encountered. It consists of rock fragments weakly cemented by very pale-brown, pinkish-gray, light-gray, and white limy interstitial material and is difficult to penetrate because of the rock. Below the hardpan, brown or grayish-brown slightly calcareous clay loam occurs in the spaces between the rock fragments. Bedrock consisting of dark-gray, brown, or very pale-brown hard basalt or andesite is at depths of 2 to 6 feet.

Many of the areas east of Baker Valley and northwest of North Powder have characteristics somewhat transitional between this soil and the Ruckles soils. These areas have a somewhat less clayey surface soil and subsoil and only a very weakly cemented calcareous hardpan, no hardpan at all, or only a lime coating on the rock fragments. Some of these included areas occupy stony foot slopes of water-laid material in which basalt predominates.

Use and management.—Lookout stony clay loam is used principally for grazing. A few small areas in Eagle Valley are partly cleared and irrigated for bluegrass pasture. Little of this soil is irrigated or cultivated in other parts of the area. Irrigated areas support a good growth of grass, but those not irrigated have an extremely thin growth and are of low grazing value. Overgrazing has caused an increase in sagebrush and a decrease in grass. Controlled and restricted grazing would aid in improving the grass cover.

Because of the high content of stones in and on the surface soil, clearing is expensive. An estimated 50 tons of rock an acre must be removed before the less stony areas can be cultivated. Only the loose surface stones are removed from some of the areas used for irrigated pasture.

Lookout stony clay loam, eroded phase (5–12% slopes) (Lo).—Eroded areas of Lookout stony clay loam make up this phase. The soil is similar to Lookout stony clay loam, though its surface layer is shallower and more irregular in depth. On much of it more than half of the surface soil has been lost through erosion, and shallow gullies are fairly common. The subsoil is exposed in small areas, and in places the surface is covered with a thin layer of overwash. Stones are strewn on the surface soil, and bedrock crops out in places.

This soil is used principally for grazing, but its value is low. Grazing should be controlled to allow the range to recuperate and to prevent further damage by erosion.

Lookout stony clay loam, hilly phase (12–25% slopes) (LP).—Stronger relief is the chief factor distinguishing this soil from Lookout stony clay loam. The two soils are rather similar, though this one has a somewhat smaller accumulation of lime in the subsoil and a less strongly developed hardpan. It is also more stony and shallow. It occurs in ravines and on hillsides below high benches. In places slopes of more than 25 percent are included.

Use and management.—Small areas of this phase below irrigation ditches in Eagle Valley are irrigated for bluegrass pasture. They furnish good pasture but wash readily. In Eagle Valley there are many small shallow gullies in irrigated areas. Elsewhere gullied areas are mapped as an eroded phase. The areas not irrigated furnish scanty range pasture.

Lookout stony clay loam, eroded hilly phase (12–25% slopes) (LN).—Eroded areas of Lookout stony clay loam, hilly phase, are mapped in this phase. A few areas with slopes greater than 25 percent are included. This phase resembles the hilly phase but it has a shallower surface soil more irregular in depth and a smaller accumulation of lime in the subsoil. Shallow gullies are fairly common, and there is some accumulation of soil material at the foot of slopes. In places the subsoil is exposed; rock outcrops are fairly common.

This phase occurs in small bodies, and an extremely small area is cultivated. Most of it is used for grazing, but it provides scanty pasture. A small acreage of pasture is irrigated. Grazing should be controlled to prevent further damage by erosion.

LUN SERIES

The Lun series includes alkali soil developed on poorly drained alluvial fans, low terraces, or old lake basins from water-laid material of mixed mineralogic origin, mainly from basalt, granite, argillite, gabbro, related rock, and soils formed thereon. Development was under a cover of mixed greasewood, sagebrush, rabbitbrush, and alkali-tolerant grasses and flowering plants including some cheatgrass (pl. 4, *B*). The annual precipitation is 10 to 12 inches. The soil seems to be more or less associated with strongly or very strongly alkaline hot springs and alkali wells along a geologic fault northeast of Baker. It differs from the associated Stanfield soil in having a less alkaline, commonly nonsalty, and generally noncalcareous surface soil and a more clayey upper subsoil.

Lun silt loam (0–2% slopes) (LR).—This soil is more or less strongly affected by alkali. It has level or nearly level relief with a faint hummocky microrelief. The content of organic matter in the surface soil is low. Surface runoff is slow and underdrainage is poor. The subsoil is very slowly permeable to roots and water. The water-holding capacity is good. The upper part of the profile is free of stones and gravel.

Profile description.—This soil typically has a fairly strongly developed subsoil. The surface soil is light brownish-gray, light-gray, or pale-brown friable silt loam or loam that extends to an average depth of 8 inches. When dry the material of the upper 1 or 2 inches is

vesicular; that of the next 1 or 2 inches is finely platy; and that in the lower part breaks into small easily crumbled aggregates. The entire surface soil is neutral or mildly alkaline and noncalcareous, or calcareous only here and there. The surface soil is dark grayish-brown when moist.

The surface soil passes abruptly into yellowish-brown, brown, or grayish-brown moderately or strongly alkaline tough compact clay or clay loam subsoil that breaks into flat-topped prisms. The upper parts of the prisms are noncalcareous; the lower parts are distinctly calcareous. The prisms break into strongly developed small to medium-sized nutlike aggregates. The material of this layer is hard to penetrate and is dark yellowish-brown or brown when moist.

At an average depth of about 18 inches, the soil becomes light yellowish-brown strongly or very strongly alkaline compact highly calcareous gritty clay loam or loam that breaks with vertical cleavage into large rough aggregates. There are many fine roots in this layer. Between depths of 27 and 40 inches, the soil is pale-brown or light yellowish-brown highly calcareous clay loam or gritty loam containing much segregated white lime.

A very pale-brown or light brownish-gray very compact layer about 12 inches thick usually occurs at an average depth of 40 inches. It is highly calcareous and strongly or very strongly alkaline, may be more or less cemented or may contain fragments of cemented material, and is usually very slowly or slowly permeable to water and fine roots. The depth to this compact layer ranges between the approximate limits of 2 to 7 feet or more, but it may be missing entirely in some places.

In most places the material next lower in profile is very pale-brown, pale-brown, or light brownish-gray somewhat compact calcareous gritty loam, but layers of finer material may be included. The substrata layers consist of gravel, sand, and other coarse calcareous alluvium. These layers are generally at a depth of 5 feet but they may occur at any depth between 4 feet and 10 or more feet. In places the soft hardpan rests directly on the gravelly substrata. The substrata material is more or less waterlogged during the wet season, and its strongly to very strongly alkaline reaction suggests that some of the water may come from hot springs. The water from wells in this soil is mostly strongly or very strongly alkaline and of poor quality for irrigation.

Use and management.—Most of Lun silt loam is used for native pasture. A few small patches near borders of individual areas are cultivated. Barley, rye, and alfalfa are grown. The crops are spotty, and yields are low. A small plot irrigated by water with a sulfurous odor from a well 200 feet deep produces 1½ tons of alfalfa an acre and fairly good crops of potatoes and garden vegetables. More of this soil was formerly cultivated. It was used for barley but was allowed to revert to native pasture because the alkali content increased.

Owing to the compact nature of the subsoil and its high content of black alkali, this soil is difficult to reclaim and would not be especially productive if the alkali were leached out. Water for irrigation is scarce in this locality and can be used more profitably on more productive soils.

McEWEN SERIES

Soils of the McEwen series are developed on old well-drained high alluvial fans and terraces under a cover of ponderosa pine and an

annual precipitation of 20 to 25 inches. The alluvial material is derived principally from granite, basalt, argillite, other metamorphic rocks, and soils formed thereon.

McEwen loam (1–10% slopes) (MA).—This soil is generally associated with Underwood and Rouen soils on the upper border of alluvial fans or terraces. It is free of alkali or excess soluble salts, and its upper layers are rather low in organic content. Some stones are present but not in quantity sufficient to interfere seriously with cultivation. The subsoil is of moderate development. It is moderately to slowly permeable to roots and moisture and has a fair to good water-holding capacity.

Profile description.—A layer of organic material 1 or 2 inches thick covers the surface in forested areas. This consists of loose pine needles in the upper part and well-decayed fluffy organic material mixed with mineral soil in the lower part. In cultivated areas this organic layer is mixed with the soil below, and in pastured cut-over areas it has a platy appearance. A few stones are strewn over the surface. The surface soil below the organic layer is brown or pale-brown friable loam to a depth of about 7 inches. This material crumbles easily into very fine crumbs or single grains. It is very dark grayish brown when moist and is slightly acid or neutral.

The upper subsoil, between depths of 7 and 18 inches, is light yellowish-brown or pale-brown somewhat compact heavy loam that breaks with a faint vertical cleavage into irregular easily crumbled nut-size aggregates. There are many roots and few pebbles in most places. This layer passes into yellowish-brown rather tough compact clay loam that breaks on vertical cleavage planes into large rough aggregates and then into nut-size aggregates. The fissure planes generally have a lustrous coating. This material ranges from heavy loam to gritty clay in texture, contains much mica and some gravel and weathered rocks, and is hard to break with a crowbar when dry.

The lower subsoil, between depths of 36 and 48 inches, is light yellowish-brown rather compact or very weakly cemented gravelly loam containing many rounded and subangular small stones. This material ranges from clay loam with imbedded gravel to gravelly sandy loam.

Below a depth of 48 inches the material is light yellowish-brown, rather loose more or less stratified gravel, sand, and cobblestones and some beds of finer material. Gold-placer diggings indicate this material goes downward to about 15 feet. The depth to the gravel ranges from 16 to 60 inches or more, and there is a corresponding range in the thickness of the soil layers above. The areas in which the depth to the gravel is greater are more generally associated with McEwen loam, deep phase. The entire profile is slightly acid to neutral in reaction and noncalcareous.

Use and management—All the virgin timber has been cut, but a stand of young second-growth trees covers uncleared areas (pl. 2). These uncleared areas are used for pasture and as a source of wood, but their grazing value is rather low.

About 35 percent of the soil has been cleared, and over half of this is used for pasture. Alfalfa and oats are the main crops. Ordinarily only one cutting of alfalfa is harvested because the growing season is short. Oats do especially well. The early rust-proof varieties commonly are grown. Barley also does well when irrigated.

No wheat is grown, as the growing season is too short. Bluegrass, alsike clover, some alfalfa, and other grasses are used for permanent pasture on cleared areas and provide good summer grazing, especially where irrigated.

Accelerated erosion has been very slight, as cleared areas are used largely for hay and pasture. Small areas have been washed out during placer mining.

McEwen loam, moderately steep phase (10–40% slopes) (Mc).—This phase is associated with McEwen loam and is of small extent. It occurs in ravines and on breaks below high terraces. Surface drainage is rapid to very rapid.

Profile description.—Occurring as it does on strongly sloping outcrops of stratified material, this phase is variable. Many subangular and rounded pebbles and cobblestones are strewn over the surface. To a depth of about 6 inches the surface soil is brown or pale-brown coarse loam containing many cobblestones and pebbles. This layer grades into light yellowish-brown or pale-brown moderately compact loam containing many cobblestones and pebbles.

Below 24 inches the material is yellowish-brown coarse alluvium consisting of gravel, rounded and subangular cobblestones, small stones, and enough fine interstitial material to make the mass coherent. The depth to the gravel ranges from a few inches on the upper part of the slopes to over 8 feet at the bottom of slopes where foot-slope or colluvial material has collected.

Use and management.—This phase is not cultivated; it is too steep and stony. The ponderosa-pine timber has been cut, and most of the slopes are now rather barren. Erosion has resulted from overgrazing the steep slopes. The soil should be kept in timber. Considerable gold has been obtained from placer mines in some areas.

McEwen loam, deep phase (1–10% slopes) (Mb).—This soil differs from McEwen loam in having a slightly deeper surface soil, a less compact subsoil, and a greater depth of material over the gravelly substratum. It is associated with McEwen loam mainly on gently sloping alluvial fans and terraces.

Profile description.—The surface soil—brown, grayish-brown, or pale-brown friable loam—extends to an average depth of 8 inches and in forested areas is covered by a thin layer of organic material. The upper subsoil, extending from a depth of 8 to 20 inches, is light yellowish-brown or pale-brown slightly compact loam. This layer passes into yellowish-brown moderately compact gritty clay loam that breaks on irregular vertical cleavage planes into aggregates rather hard to crumble. The texture ranges from a heavy loam to clay loam.

The lower subsoil, extending from a depth of 36 to 50 inches, is light yellowish-brown firm gritty loam containing some gravel and cobblestones. Below 50 inches is yellowish-brown gravel, sand, cobblestones and some fine material. The depth to the gravelly substrata ranges from 2 to 6 feet or more. A layer of brown or reddish-brown clay overlies the gravel in places.

The entire soil is noncalcareous and generally slightly acid. The surface soil is stony only where it borders the Underwood and Rouen soils. The subsoil is slowly or moderately permeable to roots and moisture and has a good water-holding capacity.

Use and management.—About 65 percent of this phase is under cultivation. Under irrigation the principal crops are alfalfa, oats, and barley. A part of the cleared area is used for pasture and provides good grazing where irrigated.

McEwen loam, overwash phase (0–5% slopes) (MD).—This phase consists of McEwen or somewhat similar soils that have been covered since about 1862 by silty or loamy deposits washed from gold placer mines. Many areas are variants of the series. The soil occupies low alluvial fans and stream bottom lands. The parent material consists of water-laid deposits of mixed mineralogic origin and includes much material derived from basalt, granite, quartz, argillite, and related rocks. Surface drainage is slow and internal drainage is medium to slow. The natural vegetation was a sparse growth of ponderosa pine, some willows, and an undergrowth of grass and sagebrush.

Profile description.—The surface soil, 6 to 36 inches or more deep, is a grayish-brown to brown loam or silt loam containing much gravel. It is very dark grayish-brown when moist, noncalcareous, slightly acid, and variable in texture. It includes layers of loam, silt loam, and clay loam that contain much gravel. The recent layer of silty wash, about 12 inches thick in the most typical areas, is abruptly replaced by a 6-inch layer of pale-brown loam or gritty clay loam containing a trace of gravel. This gritty clay loam is the surface layer of a buried soil.

The upper subsoil between 18 to 28 inches is a yellowish-brown, brown, or pale-brown firm or slightly compact clay loam containing some gravel. It breaks up into small rough easily crumbled aggregates. The material between average depths of 28 and 36 inches is pale-brown, yellowish-brown, or light yellowish-brown gravelly loam of variable texture. This material is noncalcareous and slightly acid and contains some mica. The subsoil passes into porous beds of yellowish-brown or pale-brown gravel, sand, cobblestones, and fine interstitial material that extend downward to a depth of 15 feet or more.

The profile as described gives the general sequence of the soil layers observed in a number of profiles with variable characteristics. The depth of the different layers varies with the thickness of the recent wash on the surface.

Use and management.—Nearly all of this phase has been cleared and most of it is now used for pasture. Some oats are grown under irrigation. The deposit of recent wash on the surface has apparently increased rather than decreased the productiveness of the soil.

MEHLHORN SERIES

Soils of the Mehlhorn series occupy dissected sloping lava benches or uplands. They have developed from the heavy-textured residue left in the decomposition of basalt or other lava bedrock. They formed under an annual precipitation of 15 to 25 inches and a natural vegetation of grass, bitterbrush, sagebrush, other shrubs and flowering plants, and a few scattered aspen, haw, and ponderosa pine trees.

Mehlhorn clay loam (2–12% slopes) (ME).—Relief is typically gently rolling on this soil of the uplands. Surface drainage is slow to medium. Internal drainage is slow. The soil is slowly permeable, free of soluble salts and alkali, and good in water-holding capacity.

It is noncalcareous and nearly neutral or slightly acid in reaction throughout. Much pinegrass grows on the timbered areas. In Pine Valley, Mehlhorn clay loam generally is bordered by the higher lying Underwood soils of rough, broken, and stony land and by the lower lying Applegate, Halfway, or Langrell soils. Elsewhere it is associated with Mehlhorn stony clay and the Lookout soils.

Profile description.—The surface soil is dark-brown or brown friable clay loam that usually contains many roots. When moist it is very dark brown or dark brown. The material breaks into nut-sized aggregates when first disturbed, but the aggregates are reduced with difficulty to pea-sized and fine shot-sized granules. A few stones are scattered over the surface.

The material from 6 to 15 inches is brown or slightly dark-brown heavy clay loam containing many fine roots. It is sticky when wet but breaks with a vertical cleavage into small blocks fairly easily crumbled into pea-sized granules when dry. This layer contains a variable quantity of angular stones.

The subsoil between depths of 15 and 24 inches is similar to the layer above but is browner or slightly more reddish brown and contains a larger quantity of stones. This layer grades into brown rather compact clay or clay loam containing many rock fragments. This material is faintly variegated with yellowish brown and rust brown. It contains many fine holes along old root passages, breaks into hard rough irregular aggregates, and is sticky when wet.

The lower subsoil, at depths between 36 to 60 inches, is brown clay or clay loam containing many fragments of partly decayed rock. The quantity of stone increases with depth, and at a depth of 6 to 8 feet the material grades into unweathered basalt bedrock. The depth to bedrock is variable; bedrock is within 2 feet of the surface in places.

Use and management.—In Pine Valley about 50 percent of Mehlhorn clay loam is used for irrigated crops, but much of it is irrigated only once—when spring floodwaters are available. Alfalfa is grown on about half of the irrigated area. Probably 30 percent of the cleared area is used for bluegrass pasture. The uncleared areas are used for native pasture and have a relatively high value for that purpose. The bitterbrush provides good browsing along with the grass pasture.

Like other sloping soils, this one has undergone some sheet erosion following overgrazing. The cultivated areas have been used largely for hay and pasture crops, which have minimized erosion. Hay and pasture are the crops to which the soil is best suited.

Mehlhorn clay loam, hilly phase (12–25% slopes) (MF).—Stronger relief is the main difference between this phase and Mehlhorn clay loam. This phase occurs on foot-slope and benchlike areas.

The soil consists of about 6 inches of brown clay loam overlying brown heavy clay loam that extends to a depth of 22 inches. The heavy clay loam passes into brown clay or clay loam containing many rock fragments. Basalt bedrock lies at a depth of 3 or 4 feet in most places. The entire soil is noncalcareous and neutral, or nearly so, in reaction.

About 25 percent of this phase is partly cleared and occasionally irrigated to enhance the value of the pasture. The rest is used for native pasture.

Mehlhorn stony clay loam (5–12% slopes) (Mg).—The environmental conditions under which this soil developed were similar to those for Mehlhorn clay loam. The soil differs from Mehlhorn clay loam principally in containing more stones and in being shallower to bedrock. It is associated with Mehlhorn clay loam and, in Pine Valley, with Rough broken and stony land. Surface drainage is medium but internal drainage is slow. The soil is free of soluble salts and alkali. Its water-holding capacity is fair to good because of the shallowness to bedrock.

Profile description.—The surface soil, extending to a depth of about 5 inches, is brown stony clay loam in and on which there are many angular basalt stones. This layer is dark brown when moist. Roots are plentiful but the organic content is relatively low.

The upper subsoil, or the part between depths of 5 and 14 inches, is brown stony clay loam that becomes dark brown when moist. When disturbed, this material breaks into nutlike aggregates rather difficult to reduce to smaller particles. This layer passes into brown clay or heavy clay loam containing many fragments of partly disintegrated basalt. There is some yellowish-brown variegation caused by the decayed basalt. The quantity of rock fragments increases with depth.

The lower subsoil, or that below a depth of 24 inches, is brown or light-brown clay or heavy clay loam occurring as interstitial material between rock fragments.

The parent material, occurring below 36 inches, is partly weathered basalt bedrock. The depth to this bedrock ranges from 12 to 48 inches or more. The entire soil is noncalcareous and nearly neutral in reaction.

An area in the southeast corner of Pine Valley differs from the rest of the soil in having smooth relief and in being developed from colluvial material consisting largely of angular basalt stones. Elsewhere, a few small areas overlie foot-slope and colluvial material.

Use and management.—Practically none of Mehlhorn stony clay loam is cultivated, but about 5 percent in Pine Valley is partly cleared of stone and irrigated for grass pasture and some hay. It provides good pasture where irrigated. The uncleared areas are grazed and provide pasture of average quality. Much surface soil has been lost through erosion that followed overgrazing. Over much of the area, about 25 percent of the surface soil has been lost.

Mehlhorn stony clay loam, eroded phase (5–12% slopes) (Mk).—Except for moderate or severe erosion, this soil is essentially the same as Mehlhorn stony clay loam. It includes some severely eroded areas where most of the surface soil has been lost through sheet erosion, and shallow gullies are more or less common. The most severely eroded areas were mapped as the eroded shallow phase.

This phase is rather extensive and its grazing value is about the same or slightly lower than that of Mehlhorn stony clay loam. Grazing should be controlled to prevent further damage by erosion.

Mehlhorn stony clay loam, hilly phase (12–25% slopes) (Mn).—This phase occurs mostly in V-shaped valleys cut in lava benches. Some slopes ranging up to 30 percent are included. It is used only for grazing and has a rather low value for that use.

Mehlhorn stony clay loam, eroded hilly phase (12–25% slopes) (MH).—This phase comprises hilly areas that have been moderately or severely eroded. It is similar to Mehlhorn stony clay loam but its surface soil is more irregular in depth and in places is much shallower. The more severely eroded areas are included with the eroded shallow phase. Shallow gullies and rock outcrops are fairly common locally. The soil occurs mostly along V-shaped ravines that extend into sloping lava benches. Its grazing value is low, and grazing should be controlled to prevent further damage through erosion.

Mehlhorn stony clay loam, eroded steep phase (25–50% slopes) (MM).—Relief this phase is semimountainous or mountainous. It is similar to Mehlhorn stony clay loam but more variable and generally shallower in depth to bedrock and has a thinner surface soil and many rock outcrops. It occurs in V-shaped canyons cut into lava benches. Surface drainage is very rapid, and the phase has lost over 25 percent of the surface soil through erosion. The native vegetation furnishes range pasture of low value.

Mehlhorn stony clay loam, eroded shallow phase (5–25% slopes) (ML).—At least 75 percent of the surface soil and in places part of the subsoil have been eroded from this phase. In many areas shallow gullies have formed. The phase is similar to Mehlhorn stony clay loam but is more eroded, shallower to bedrock, and stonier in most places. The exposure of the subsoil gives this phase a reddish-brown cast.

This phase occurs principally along old stock drives, and only scattered sagebrush and tufts of grass remain on these trampled areas. The stock-drive strips have practically no grazing value but are needed at the beginning and end of the summer grazing season for moving stock to and from the grazing lands in the National forest. Most of the areas are gently sloping or hilly, but small areas with steep slopes are included.

MOSCOW SERIES

Soils of the Moscow series have developed in upland areas under a cover of ponderosa pine, other trees, and bitterbrush, principally on residuum weathered from albite granite bedrock. Development has been under a higher precipitation that that for the grass- and sagebrush-covered soils. Moscow soils differ from the Brownlee in being forested, lighter colored, and more acid. They differ from the related Kilmerque soils in being derived principally from residuum of albite granite rather than biotite-quartz diorite and in having a more compact subsoil.

Moscow loam (2–25% slopes) (MP).—The larger areas of this soil are associated with the Brownlee soils. Relief ranges from gently sloping on ridge tops to hilly, but for the greater part it is rolling. Natural drainage is good. The soil is moderately permeable to water, but its water-holding capacity is limited by the shallowness to bedrock.

Profile description.—The soil has a moderately developed profile. Under virgin conditions a 1-inch layer of organic material covers the surface. The upper part of this organic layer, principally undecomposed loose pine needles, grades into dark-gray or dark grayish-

brown medium or slightly acid decayed pine needles and some white mycelia from molds. The organic layer is underlain by about 1 inch of grayish-brown very friable loam mixed with some well-decayed organic material. This loam material is very dark brown or very dark gray when moist.

To about 12 inches the soil is pale-brown slightly acid to neutral very friable light loam containing considerable sand and fine gravel. The upper part has a weak very fine crumb or granular structure, whereas the lower part breaks into small easily crumbled nut- or pea-sized aggregates. This layer is dark grayish brown and somewhat sticky when moist.

The upper subsoil, between depths of 12 and 18 inches, is light yellowish-brown or pale-brown loam containing many disintegrated granite fragments. It is slightly compact but crumbles easily into rounded fine nutlike aggregates.

The lower subsoil, between depths of 18 and 24 inches, is variegated yellowish-brown and brownish-yellow sandy loam mixed with disintegrating granite fragments. It rests on splotched brownish-yellow, very pale-brown, reddish-yellow, or white weathered albite granite. Dark streaks follow root channels to a depth of 48 inches or more. Below 48 inches the rock is little altered, and it grades into bedrock. The entire profile of this soil is noncalcareous and slightly acid to neutral.

Included with this soil in mapping are small areas overlying greenstone. In such areas the subsoil is rust-brown compact prismatic clay loam from a depth of 12 to 24 inches. Fissure planes in the subsoil have a lustrous coating and some grayish-brown stains. The subsoil from 24 to 48 inches is rock with brown clay loam in the spaces between. The lower subsoil material between the broken rock is brown clay loam, and at about 72 inches this part of the profile grades into slightly weathered greenstone.

Use and management.—Moscow loam is used principally for wood and timber production. None of it is cultivated. The present vegetation is a young growth of ponderosa pine with some pinegrass, bitterbrush, and other shrubs that furnish scant grazing.

Moscow loam, eroded phase (2–25% slopes) (MR).—Except for its shallower surface soil caused by erosion, this phase is similar to Moscow loam. In places most of the surface soil has been lost and the subsoil is exposed. Shallow gullies occur in some localities. Owing to the shallow nature of the soil, even slight surface erosion is noticeable.

Most of the natural vegetation of ponderosa pine has been removed, and the soil now is used for pasture. The grazing value is low. The soil is better suited to wood production than to grazing. It requires careful use to prevent further erosion.

Moscow loam, steep phase (25–50% slopes) (MT).—Except for being steeper, more stony, and more variable in depth, the soil is similar to Moscow loam. It is covered with scrubby young pines and is not cultivated.

Moscow loam, eroded steep phase (25–50% slopes) (Ms).—This soil lies principally along V-shaped ravines, where the dominant slope generally ranges from 25 to 35 percent. Slopes are steeper than

those of Moscow loam, and because of greater erosion the profile is shallower, stonier, and more irregular in depth; otherwise the two soils are similar. There are a few shallow gullies in places, but severe sheet erosion is unusual. Owing to the shallowness of the soil, even slight erosion is easily detected. Most of the scrubby ponderosa pine has been removed, and the areas are used for grazing. This soil is poor for grazing and is apparently better suited to use as a source of the farm wood supply.

MUCK

Muck (0–1% slopes) (Mu) consists of marshy areas covered with water much of the year. It occurs in small scattered bodies and has a total extent of about 170 acres. The native vegetation is mainly cattails and sedges and in places a few willows and haws.

The surface soil, to a depth of about 9 inches, is very dark-brown, dark-brown, or very dark-gray peaty muck containing more or less mineral material and many roots. A thin mat of partly decayed sedges and cattails is on the surface. The material between depths of 9 and 16 inches is very dark gray well-disintegrated muck containing much mineral soil. It is underlain by layers of dark-gray, gray, or grayish-brown silty clay loam, sandy loam, and loam. The thickness of the organic layer ranges from 10 to 40 inches or more. Gravelly material occurs at depths of 24 to 40 inches in many areas. The soil is noncalcareous. In Pine and Sumpter Valleys it is slightly to strongly acid but in other areas it is almost neutral.

Muck is not cultivated but furnishes some pasture in dry periods. Muskrats, which thrive in the wettest areas, are trapped for their pelts and bring considerable income. Muck lies in basinlike areas and would be difficult to drain except by pumping.

NORTH POWDER SERIES

Soils of the North Powder series cover extensive areas and have formed mainly from residuum weathered from biotite-quartz diorite bedrock (*1*)—a coarsely crystalline rock—and in places from weathered granite. Small areas derived from dioritic or granitic foot-slope or colluvial material or from residuum weathered from greenstone are included in mapping. In some areas the surface soil may be influenced somewhat by or derived from loessal or loesslike material. Typical North Powder soils have not developed on other intrusive rocks in the region, whereas the Brownlee soils have developed on albite granite and have darker surface soils, and Ruckles soils have formed on various types of lava rock and gabbro. The North Powder soils occur on undulating to hilly uplands. The annual precipitation is 10 to 14 inches.

North Powder loam has a moderately calcareous lower subsoil, whereas the eroded shallow phase has less lime accumulation in the lower subsoil. In general, areas with smooth relief have a more compact upper subsoil than do the areas with rolling or hilly relief. Stony areas indicated by stone symbols on the soil map generally have steep relief, very shallow soil, and little lime accumulation in the subsoil.

North Powder loam (1–12% slopes) (Na).—Most areas of this light-colored soil have gently rolling, rolling, or undulating relief.

The soil is moderately permeable, well-drained, free from salts and alkali, and has a fair to good water-holding capacity. The natural vegetation is sagebrush, grass, and low semiarid shrubs. The most common grasses are Sandberg bluegrass, cheatgrass, big bunchgrass, wild barley, Indian ricegrass, and needle-and-thread grass.

Profile description.—This soil has a moderately developed profile. The surface 6 inches is light brownish-gray, pale-brown, or grayish-brown noncalcareous mildly alkaline friable gritty loam. This layer is dark grayish brown when moist, and has a few stones strewn over the surface in places. From 6 to 13 inches the soil is faintly lighter colored gritty loam that is slightly more alkaline than the soil above. Like the surface layer it is friable and easily crumbled, and it contains many plant roots. This material grades into pale-brown gritty noncalcareous slightly compact loam.

The upper subsoil, between depths of 13 to 18 inches, is brown, or pale-brown, moderately compact sandy clay loam containing considerable coarse sand. It breaks into hard subangular small or medium nutlike aggregates. When wet, the material is sticky. In most places it is noncalcareous but may contain specks of lime in the lower part.

From a depth of about 18 to 22 inches, the subsoil is pale-brown or yellowish-brown moderately compact calcareous sandy clay loam. The material varies from a sticky or softly cemented sandy loam to a gritty clay loam.

From 22 to 36 inches the soil is light yellowish-brown or yellowish-brown sandy loam containing spots and streaks of segregated white lime (pl. 4, *C*). This material is somewhat compact, crumbles easily, and contains much mica and some partly disintegrated rock fragments. The quantity of the rock fragments increases with depth.

Disintegrating biotite-quartz diorite, the parent material, is at an average depth of 36 inches. The depth, however, ranges from 1 to 6 feet in short distances, and there is a corresponding range in the thickness of the soil layers. The diorite is noncalcareous, but streaks of lime occur in fissures in the rock. Plant roots go down to the rock.

A few areas north of Haines and elsewhere that have fairly smooth or undulating relief have a more strongly developed subsoil than typical. In these areas the surface soil is a pale-brown noncalcareous friable gritty loam that extends to a depth of about 11 inches. The upper subsoil, continuing to a depth of 26 inches, is yellowish-brown or light yellowish-brown rather compact gritty clay loam that separates with a faint vertical breakage into small irregular blocks or hard subangular small or medium nutlike aggregates. This layer is sticky when wet.

The next layer continues to a depth of about 36 inches. It is a light yellowish-brown highly calcareous moderately compact gritty loam or sandy loam that contains much segregated white lime. This material is underlain by light yellowish-brown friable micaceous sandy loam, generally noncalcareous, that contains some disintegrating rock fragments. Gradually replacing this material is weathered biotite-quartz diorite or granite bedrock, which occurs at an average depth of 4 feet. The depth to the bedrock varies, and there is a corresponding variation in the thickness of the soil layers above.

Use and management.—North Powder loam is used mainly for grazing, and for this use it is about average. A small tract north of

Haines is cultivated under irrigation, but owing to its elevated position and choppy relief, the soil is generally difficult to irrigate. Irrigation water is relatively scarce in this area and could be used to better advantage on more productive soils. Less than 2 percent of the soil is cultivated. Under irrigation yields are moderate..

Most of this soil is best suited to range pasture. Some stones occur on all of this soil, and a few are more than 5 feet in diameter. The soil does not wash easily for its subsoil is permeable, but some accelerated sheet and gully erosion have been caused by overgrazing.

North Powder loam, eroded phase (3–12% slopes) (Nc).—Appreciably eroded areas of North Powder loam make up this phase. It is similar to North Powder loam, but its surface soil is shallower and more irregular in depth, and shallow gullies occur in places. Practically all of this soil is used for grazing. Its grazing value is somewhat lower than that of North Powder loam.

North Powder loam, eroded hilly phase (12–25% slopes) (Nb).—This phase consists of eroded areas. It resembles North Powder loam, but its surface soil is stonier, shallower, and more irregular in depth; its subsoil is coarser textured, less compact, and contains less accumulation of lime; and its relief is hilly. Dominant slopes are between 15 and 20 percent. Moderate sheet erosion has caused some damage, and shallow gullies have formed in places. The soil is used for range pasture. Its value for grazing is lower than that of North Powder loam. Grazing should be controlled to prevent further damage by erosion.

North Powder loam, eroded shallow phase (5–20% slopes) (Nd).—This phase differs from the normal phase principally in being shallower and more eroded and in having somewhat less well-defined profile layers. It occurs in scattered bodies. Much of it has undergone moderate sheet erosion, and a few areas are severely eroded. A few shallow gullies have been cut in places. Owing to the shallowness of the soil, any erosion is noticeable. Dominant slopes range from 5 to 20 percent but areas with slopes of 50 percent or more are included. This soil is permeable, and plant roots grow into the fissures in the underlying weathered rock. It has fair to low water-holding capacity, is well-drained, and is free of salts and alkali.

Profile description.—The surface soil—grayish-brown, light brownish-gray or pale-brown neutral to mildly alkaline very friable gritty loam—extends to a depth of about 8 inches. Many dioritic or granitic rock fragments and stones are scattered on and in this layer, and it is dark grayish-brown when moist.

The upper subsoil, between depths of 8 and 12 inches, is brown slightly compact sandy clay loam containing many rock fragments. This material breaks vertically into hard irregular fine nutlike aggregates, is calcareous, and grades into variegated yellow and pale-brown weathered biotite-quartz diorite or granite bedrock. Where the depth to bedrock is greater, a yellowish-brown slightly calcareous sandy loam overlies the weathered rock.

Areas indicated on the soil map by stone symbols generally have steeper relief and are much stonier. In these areas many dioritic or granitic stones are scattered on and in the surface soil and rock outcrops are fairly common. The subsoil ranges from stony loam to stony sandy clay loam, and the lower part is calcareous in places.

The quantity of rock increases with increase in depth, and the soil is underlain by weathered bedrock at an average depth of 2 feet The depth to bedrock varies greatly, however, because of the hilly relief. Slopes in these stony areas generally range from 20 to 40 percent but may be steeper or less steep.

Use and management.—This phase is used entirely for pasture. Its grazing value is somewhat lower than average. The range has been somewhat depleted by overgrazing. Strict grazing control is needed to prevent further erosion and damage to the range. The number of livestock should be carefully adjusted to a safe carrying capacity, grazing should be deferred in the spring until plants have attained several inches growth, and rotational grazing is advisable. Some areas may need reseeding.

ONYX SERIES

Soils of the Onyx series have formed from recent alluvial material under a cover of sagebrush and grass where the annual precipitation is 10 to 13 inches. The parent material is of mixed origin but comes largely from basalt, granite, argillite, greenstone, and associated rocks. It contains much mica. Relief is nearly level except in areas cut by small stream channels. In places the soils are sometimes flooded early in spring, but drainage is adequate for general farm crops. A few willows grow along stream channels. Most of the larger areas are cultivated where water for irrigation is available. Onyx soils occur in widely scattered areas. They differ from the related Powder soils in being noncalcareous, and they are better drained than the Hershal and Baldock soils.

Onyx silt loam (0–2% slopes) (OA).—This deep permeable well-drained or moderately well-drained soil formed on nearly level stream bottom land and recent or very young alluvial fans. The water-holding capacity is good.

Profile description.—The soil shows very little or no differentiation in texture and structure of layers. The upper 10 or 12 inches is grayish-brown, dark grayish brown, or brown crumbly or weakly very fine granular silt loam or loam. This material is very dark brown when moist; its organic content is rather low or fair. The surface soil is free of stones and rather free of gravel but is coarser textured near stream channels. It is noncalcareous and mildly alkaline to neutral in most places.

The layer between 10 or 12 and 36 inches is grayish-brown or brown friable micaceous silt loam or loam. This material is dark brown or very dark grayish brown when moist, becomes coarser with increasing depth, and in places includes thin layers of fine sandy loam and a trace of gravel in the lower part. In typical areas this material is noncalcareous and mildly alkaline or neutral, but as the soil is mapped, areas with occasional calcareous layers in the subsoil are included. The layer between 36 and 60 inches is light yellowish-brown, brown, or grayish-brown micaceous loam in which occur layers of silt loam and fine sandy loam and a trace of gravel. In places some rust-brown and gray mottlings are present.

Below 60 inches the material consists of grayish-brown, light olive-brown, or gray sandy loam, gravelly loam, gravel, cobblestones, and layers of fine sediment. These materials extend to a depth of over

10 feet and are noncalcareous and about neutral in most places. The entire profile may show stratification.

Use and management.—Probably 60 percent of this soil in Baker Valley is under cultivation, but because irrigation water is lacking, only about 35 percent of it in the Lower Powder Valley is cultivated. Alfalfa is grown on about 40 percent of the cultivated area, and under irrigation. Spring wheat follows alfalfa in acreage. Oats and barley are also grown. Wheat, rye, and hay are produced in small dry-farmed areas. If a mixture of bluegrass, timothy, clover, and native grasses is irrigated, 2 acres will provide summer pasture for one cow. Without irrigation the pasture is scanty.

Owing to smooth relief, surface erosion has caused little apparent damage. Deposition has about been equal to any surface erosion of the soil. A few small gullies have been cut along intermittent stream channels. Many small streams are becoming more deeply entrenched.

Some areas would be improved by better drainage. The quantity of soluble salts in the soil is apparently increasing in irrigated areas, especially where some of the water comes from hot springs or as runoff from soils containing salts.

Onyx silt loam, gravelly subsoil phase (0–2% slopes) (Od).—This phase resembles Onyx silt loam but its gravelly layer is at a depth of less than 36 inches. Much of it occurs nearer stream channels and at lower elevation than Onyx silt loam. The soil is noncalcareous throughout and neutral to slightly acid. The surface soil contains some gravel in places, and small areas near stream channels are included that have a fine sandy loam surface soil.

Profile description.—The surface soil—a grayish-brown or brown silt loam or loam—extends to an average depth of 10 inches. It overlies grayish-brown, brown, or yellowish-brown silt loam, loam, or fine sandy loam that continues to an average depth of 24 inches. The lower material consists of beds of grayish-brown or pale-brown porous gravelly loam, sand, gravel, cobblestones, and fine sediments.

Use and management.—Probably 40 percent of this phase is cultivated. Alfalfa, wheat, and oats are grown under irrigation. The grazing value is about the same as that of Onyx silt loam. Erosion has caused little apparent damage to the soil, although gullies have formed in places along stream channels. The content of soluble salts is slowly increasing in irrigated areas.

Onyx silt loam, alluvial-fan phase (2–5% slopes) (Ob).—This phase resembles Onyx silt loam in most respects but occurs on gently sloping young alluvial fans and has a subsoil slightly more compact and more prominent. Owing to the more compact subsoil, greater slope, and greater surface runoff, this phase is a variant of the Onyx series. The surface soil is free of stones and gravel; the subsoil is moderately permeable to roots, water, and air, and has a good water-holding capacity. Natural drainage is good. Where this soil borders other soils its lower subsoil may be slightly calcareous.

Profile description.—The surface soil is grayish-brown, dark grayish-brown, or brown friable silt loam or loam to a depth of 8 inches. It is very dark brown when moist and contains a low or moderate quantity of organic matter. This layer passes into grayish-brown or brown friable silt loam that breaks into large easily crumbled aggre-

gates. Like the rest of the profile, the surface layers are noncalcareous and neutral or slightly acid.

The subsoil between 18 and 30 inches is brown or yellowish-brown friable or slightly compact heavy loam that breaks into large easily crumbled aggregates. Gradually replacing this is brown or yellowish-brown silt loam that contains a trace of gravel and, in a few places, lenses of sandy loam. This material breaks into irregular easily crumbled aggregates that become less firm with increase in depth.

At a depth of about 5 feet the soil is underlain by irregular stratified layers of highly micaceous gravel, sand, and gravelly loam containing many water-worn cobblestones and enough fine material to make a cut bank stand up well.

Use and management.—This phase is exceptionally productive and especially well suited to alfalfa and wheat. Probably 90 percent of it is cultivated. Nearly all of the areas are cultivated where water for irrigation is available. Alfalfa is grown on over 50 percent of the cultivated land. Other crops grown are wheat, oats, and barley. The hay and pasture crops grown retard erosion, but some surface soil has been lost through irrigation and wind erosion.

Onyx silt loam, eroded alluvial-fan phase (2–5% slopes) (Oc).—Except for its being moderately or severely eroded, this phase is similar to the alluvial-fan phase of Onyx silt loam. Like the alluvial-fan phase, this phase is a variant of the Onyx series. In most places 25 percent or more of the original surface soil has been lost through erosion, and shallow gullies occur in a few places. This phase is associated with and is used in about the same way as the alluvial-fan phase but is slightly less productive.

PLACER DIGGINGS

Placer diggings (0–25% slopes) (Pa) consists of pits and spoil dumps left in placer mining for gold-bearing alluvial deposits. Before they were disturbed, the areas were mostly nearly level and consisted of alluvial soil, usually about 5 feet thick, overlying beds of gold-bearing gravel 10 to 35 feet thick. Nearly all the alluvium has been removed down to the underlying bedrock, and the resulting pits are sometimes partly filled with water.

The closely spaced large dome-shaped spoil dumps near the pits consist of a mixture of cobblestones, stones, gravel, and some interstitial material from which the gold and much of the finer sediments have been washed. This coarse debris is composed of granite, gabbro, quartz, quartzite, basalt, argillite, and related hard dense rock.

The pits remain barren of vegetation, but about 10 years after mining operations cease, the spoil dumps support a sparse growth of weeds, willows, and ponderosa pine seedlings. The pines develop a scrubby growth on diggings undisturbed for more than 50 years. Placer diggings may in time produce timber, but they have no agricultural value.

POWDER SERIES

Soil of the Powder series formed from alluvial material under good to moderately good natural drainage and an annual precipitation of 10 to 13 inches. The alluvium is mixed but is derived principally from basalt, argillite, greenstone, granite, related kinds of rock, and soils formed thereon. The Powder soil resembles the associated

Onyx soils but differs from them in having a calcareous subsoil. It occurs in widely scattered areas in Baker Valley and in parts of Lower Powder Valley.

Powder silt loam (0–2% slopes) (Pb).—This deep permeable soil occurs mostly on level or nearly level stream bottom lands and low alluvial fans. Relief is smooth except for slight irregularities caused by stream channels. The natural vegetation is mainly sagebrush and grass but includes some rabbittbrush and many other plants. The soil is free of excess soluble salts and alkali except in areas where it borders saline soils. The subsoil is moderately permeable to water, air, and roots. Fine roots go to a depth of 6 feet.

Profile description.—The surface 8 to 20 inches is pale-brown, light brownish-gray, or grayish-brown friable silt loam or loam. This layer is reasonably free of gravel and stones, generally non-calcareous and mildly alkaline or neutral in reaction, and low in organic content. It is dark grayish brown when moist. In virgin areas the upper part is weakly root-bound and slightly platy. The lower part breaks into small easily crumbled aggregates.

The surface soil overlies pale-brown or light brownish-gray calcareous friable loam or silt loam that breaks into small aggregates. White specks and fine streaks of segregated lime are common below a depth of about 2 feet, and there are many fine roots. This layer is mildly to strongly alkaline and coarser with increasing depth. It grades into pale-brown, very pale-brown, or light-gray loam with a few layers of fine sandy loam, silt loam, clay loam, and some gravel in places.

The material below 6 feet consists of beds of loam, sandy loam, and gravel. Here and there the material in these beds is calcareous, and it is commonly mildly alkaline. Nonetheless, layers with either a neutral or strongly alkaline reaction may occur in any part of the profile down to a depth of 10 feet or more. Thin softly cemented hardpans may occur below a depth of 5 feet in places.

Use and management.—An estimated 65 percent of the Powder silt loam in Baker Valley is cultivated under irrigation. Probably not more than 35 percent of it in the locality of Lower Powder Valley is cultivated, for in this area much of it occurs in narrow stream bottoms where no water is available. Alfalfa is the most important crop. Wheat ranks second in acreage. Oats and barley are also grown. A few small dry-farmed plots produce wheat and rye. This soil provides excellent pasture where irrigated. Areas not irrigated have been badly overgrazed and furnish rather scanty pasture.

Surface erosion has caused little apparent damage because relief is nearly level, but gullies have caused considerable injury in some areas east of Baker Valley. In places intermittent streams have cut gullies 3 to 10 feet deep, and this has caused excessive drainage for native pasture. Small gullies have begun branching out from the main channel in places. Steps should be taken to prevent extension of these gullies.

RIVERWASH

Riverwash (0–2% slopes) (Ra) usually consists of a heterogeneous deposit of brownish-gray sand, gravel, cobblestones, and rounded stones occurring in stream bottoms. The parts of the areas nearest the streams are bare of vegetation; parts farther away support a

few scattered scrubby willows and cottonwoods. The material has developed no soil layers and has little or no agricultural value. It is of value as a source of commercial sand and gravel, and some gold has been obtained from it by placer miners.

ROUEN SERIES

Soils of the Rouen series are light-colored, acid, and have developed in uplands under forest cover from argillite bedrock. This rock is fine-grained, highly folded, very hard, and resistant to weathering. It is dark gray with a slight bluish cast and has a characteristic wavy marbled appearance. In many places the upper part of the profile may be influenced more or less by or derived from loessal or loesslike material. Rouen soils have a rounded mountainous relief unlike that of the benchlike areas characterizing the location of Underwood soils. The ravines and valleys are rounded and broaden out at the upper ends. Differences of altitude up to 1,000 feet within a mile are common. The organic content of Rouen soils is relatively low, and these soils are the most acid in the Baker area. The water-holding capacity is limited by the shallow depth to bedrock.

Rouen stony loam (2–15% slopes) (RB).—The relief on this soil is mostly moderately sloping. Surface drainage is slow to medium; internal drainage is slow because of the heavy subsoil. The subsoil is slowly permeable to roots and water and has a good water-holding capacity. The soil is associated with the steep phase of Rouen stony loam, which occurs on lower slopes and ravines, and with Rough broken and stony land. The natural vegetation is mainly ponderosa pine with some western larch (tamarack), Douglas-fir, white fir, cedar, mountain-mahogany, snowberry, and other trees and shrubs. The proportion of pine diminishes at higher altitudes.

Profile description.—In virgin areas the surface soil is covered with a layer of very strongly acid organic material 1 or 1½ inches thick. This layer consists of loose pine needles at the surface and partly decayed leafmold in the lower part. It overlies dark grayish-brown strongly or very strongly acid stony loam about 2 inches deep. This material is very dark brown or dark gray when moist. The loam passes into very pale-brown strongly acid friable gritty loam containing some angular rock fragments. The soil of this layer breaks into small, easily crumbled aggregates and is yellowish brown when moist. Many stones are on and in the surface soil.

The upper subsoil from 12 to 20 inches is very pale-brown strongly acid gritty clay loam or loam containing many angular rock fragments. It is friable, breaks into small rough aggregates, and grades abruptly into brownish-yellow medium or strongly acid tough compact clay loam or clay. This compact clay is variegated with rust-brown and black specks, contains many rock fragments, is irregularly prismatic, and has lustrous coatings on the fissure planes. Many fine roots penetrate this layer.

The weathered parent rock, consisting of mixed yellowish-brown, brown, rust-brown, and dark-gray slightly acid very hard argillite, is at a depth of 50 or 60 inches. It grades into dark-gray unweathered argillite bedrock. The depth to bedrock varies greatly within short distances.

As mapped, this is a variable soil. The surface soil ranges from a heavy loam to sandy loam, and the subsoil, from clay or sandy clay to clay loam. The depth to bedrock is relatively shallow on higher slopes and deep on lower ones where narrow belts of colluvial material are included. On lower slopes the soil is very pale-brown silt loam or fine sandy loam to a depth of 2 or 3 feet, where it overlies gritty clay loam containing much subangular rock. The gritty clay loam extends to a depth of 5 feet or more. The material with the very pale-brown color somewhat resembles volcanic ash and is always associated with Rouen soils.

Use and management.—The forests on Rouen stony loam have been cut over, but at one time the soil apparently supported a good stand of timber. Practically all of the land is now covered by a good stand of young trees. Much of the soil is grazed lightly in the early summer, but it is best suited to the production of timber. None of it is cultivated. Because of a good cover of leafmold, there has been extremely little erosion.

Rouen stony loam, steep phase (15–35% slopes) (Rc).—This phase consists of areas of Rouen stony loam with steep or hilly relief. It is similar to Rouen stony loam but is stonier and shallower in all areas except those at the foot of slopes. It has about the same acreage as Rouen stony loam and a nearly equal stand of timber. It is suited only to forestry. Some placer gold has been mined, and many mine prospects have been made in the gravel deposits in ravines throughout the area.

ROUGH BROKEN AND STONY LAND

Rough broken and stony land (30–60% slopes) (Rd) is by far the most extensive separation mapped in the Baker area. It consists of steep mountainous areas where rock outcrops are common, and of small less steep areas where rock outcrops have little or no soil cover.

This land includes many soils impractical to map because of steep relief. Except for being steeper and more stony, the soil in a specific area resembles the soil shown adjoining it on the map. Areas bordering Ruckles soils are generally covered with sagebrush and grass and have some accumulation of lime in the subsoil, as is characteristic of sagebrush-covered soils in the Baker area. Areas bordering Kilmerque, Underwood, Moscow, or Rouen soils are generally forested and have an acid surface soil and subsoil and no accumulation of lime. Areas north of Elkhorn Mine are underlain chiefly by biotite-quartz diorite, a coarsely crystalline rock, and have soils similar to Kilmerque sandy loam. Extensive areas south of Elkhorn Mine are underlain by argillite and have soils similar to Rouen stony loam. Areas surrounding Pine Valley are underlain largely by lava rock and have soils similar to Underwood loam. Many scattered forested bodies in other parts of this land type are underlain by lava rock.

Most of the soils of this land type are shallow. They generally range from 1 to 3 feet thick over weathered bedrock. Many loose stones are usually scattered over and in the surface soil. Relief is rugged. High, nearly perpendicular escarpments are fairly common in areas underlain by lava rock. Natural drainage is excessive. Surface erosion resulting from overgrazing has caused serious damage in areas covered with sagebrush and grass. Erosion is very conspicuous on steep hillsides and consequently the land type appears

more highly eroded than it actually is. All of it should be grazed sparingly, and grazing should be curtailed entirely on seriously eroded areas. Erosion has caused little damage in timbered areas, because most of these have been grazed very lightly.

Much of the original timber has been cut; most areas are now covered with young second-growth ponderosa pine, western larch (tamarack), Douglas-fir, and other trees. White and alpine firs, lodgepole pine, and related species are more common at altitudes above 6,000 feet. Where forested, Rough broken and stony land is best used for the production of timber.

RUCKLES SERIES

The extensive well-drained soils of the Ruckles series have developed principally in uplands under a cover of big sagebrush and bunchgrasses (pl. 5, *A*). The annual precipitation is 10 to 13 inches. The parent material in typical areas consists of residuum from basic igneous bedrock, largely basalt, andesite, and gabbro. Some areas of soil developed from old fluviatile deposits containing much lava rock are included with Ruckles soils, but such areas are not typical of the series. In many places the surface soil may be influenced by wind-deposited silty or loesslike material. The thicknesses of the different soil layers in the Ruckles series varies greatly because of differences in depth to bedrock.

Relief is typically that of sloping lava benches dissected by many shallow ravines, but many foot slope and colluvial areas are included. The steeper areas of Ruckles soils are mapped as Rough broken and stony land. The larger areas are in many places associated with the Virtue and Keating soils. Ruckles soils are somewhat lighter colored than the Keating soils and are derived from different materials. They differ from the Lookout soils principally in having somewhat less strongly differentiated layers in the profile and in lacking a strongly cemented lime hardpan.

Ruckles loam (5–12% slopes) (Re).—This is one of the more extensive soils in the area. Relief is typically gently rolling, though there are a few shallow ravines. In some areas slopes are less than 5 percent, and in a few, especially on range land, they are steeper than 12 percent. Surface drainage is medium, and the soil is free of soluble salts and alkali. The water-holding capacity is fair because of the high content of rock. The soil is slowly permeable to water and in many places roots go down to a depth of 50 inches. Generally associated with this soil are other Ruckles soils or those of the Virtue, Baker, or North Powder series. Many areas are bordered by Rough broken and stony land.

Profile description.—To a depth of about 3 inches the surface soil is light brownish-gray loam. This layer is low in organic content. It grades into pale-brown loam. The surface soil contains some angular pebbles and stones. The material crumbles easily into very fine granules and is noncalcareous, neutral in reaction, low in content of organic matter, and dark grayish brown when moist.

At a depth of about 8 or 10 inches the surface soil grades into a subsoil of brown mildly or moderately alkaline noncalcareous moderately tough compact irregularly prismatic clay loam or clay. This material contains considerable angular rock fragments and many fine

roots and breaks into very hard strongly developed fine nutlike aggregates. At a depth of about 17 inches this layer grades into brown to pale-brown gritty loam or sandy clay loam containing many angular rock fragments. These fragments increase in number with increase in depth.

Below a depth of about 22 inches the subsoil consists of large angular rock fragments and interstitial pale-brown to light yellowish-brown gritty loam containing many small rock fragments. A very pale-brown or light yellowish-brown rather compact layer of calcareous gritty loam occurs below a depth of 26 to 35 inches. It contains many lime-coated rock fragments that are in places weakly cemented by lime. Below this layer the quantity of fine material between the rock fragments decreases, and in typical areas there is gradation to solid basalt or other basic igneous bedrock at depths of 2½ to 4 feet.

East of Haines some areas have a dense compact calcareous layer, somewhat like the hardpan in the Virtue soils, at depths of 30 to 40 inches. The steeper areas of Ruckles loam are stonier. In many areas at the foot of slopes this soil has formed from talus or colluvial or alluvial material. The depth to bedrock in these areas may be considerably greater than typical. Extensive areas around Lower Powder Valley are derived from old stony fluviatile material. Here, the stones are mainly basalt, andesite, and rhyolite. Small areas of soils underlain by gabbro and greenstone are included.

Use and management.—Ruckles loam is used for range pasture in spring and is considered average as range land. The grass is now rather thin, but areas that have not been overgrazed have a fairly good cover. There is little growth of grass in the dry summer and fall, but stock do some browsing on the brush throughout the year. Like other range land in the area, the productive capacity of this soil has been greatly reduced by prolonged overgrazing. The growth of sagebrush has increased at the expense of the grass. Probably 25 percent of the surface soil has been lost through sheet erosion following overgrazing. Controlled grazing is a prime necessity for this soil. The former grazing capacity could be entirely restored only through very slow processes, but further deterioration can be prevented.

Practically none of this soil is under cultivation, but a few areas have been partly cleared of sagebrush to increase their value for grazing. Much of it could be used for hay and pasture under irrigation, but water is scarce in this area and it can be used to better advantage on more productive soils. Most of this soil occurs on rather high dissected benches where it would be difficult to bring irrigation water, even if it were available.

Ruckles loam, eroded phase (5–12% slopes) (RH).—In this phase are areas of Ruckles loam that have been appreciably eroded. This phase is similar to the normal phase, but its surface soil is thinner, generally less than 5 inches thick, and more variable in thickness. The subsoil is exposed in places, and shallow gullies are fairly common.

Small areas are cultivated, but most of this soil is used for range grazing. It has a somewhat lower grazing value than Ruckles loam. Grazing should be carefully controlled to prevent further erosion.

Ruckles loam, hilly phase (12–25% slopes) (RL).—This phase is similar to Ruckles loam but more variable in depth and generally

somewhat shallower. It is extensive in the area surrounding Lower Powder Valley. Nearly all of it is used for grazing, for which it has a slightly lower value than Ruckles loam. A few areas are cultivated where the slope is slightly over 12 percent. Erosion has been more active than on Ruckles loam and the soil should be carefully protected from overgrazing to prevent further erosion.

Ruckles loam, eroded hilly phase (12–25% slopes) (RG).—This phase is cut by gullies and has lost much of its surface soil through accelerated erosion. In profile it is similar to Ruckles loam, but the surface soil is shallower and in places the subsoil is exposed. The soil occurs in small scattered bodies and is used chiefly for range pasture. Slopes do not exceed 20 percent in the cultivated areas. Grazing should be rigidly controlled to prevent further damage from erosion and to permit an increase in the growth and density of range grasses.

Ruckles loam, steep phase (25–45% slopes) (RM).—This phase occurs along deep ravines on the breaks below lava benches. In most profile characteristics it is similar to Ruckles loam, but it is more variable in depth, generally shallower, somewhat stonier, and less limy in the subsoil. Surface runoff is very rapid. Bedrock crops out in places. The soil is used solely for range pasture. Much of it has lost more than 25 percent of the surface soil as a result of overgrazing.

Ruckles loam, eroded steep phase (25–45% slopes) (RK).—The surface soil is shallower and stonier and the subsoil is shallower, less compact, and lower in content of lime, but in other respects this phase resembles Ruckles loam. More than 50 percent of the surface soil has been lost through erosion, and rock outcrops occur on the steeper slopes.

This phase is used chiefly for range grazing but is of low value for that use. Grazing should be controlled to reduce erosion. A few cultivated areas with slopes of more than 20 percent are included with this phase. These included areas have lost much of their surface soil through erosion and are cut by gullies.

Ruckles loam, deep phase (2–7% slopes) (RF).—This phase differs chiefly from Ruckles loam in being deeper to bedrock and in being derived to a considerable extent from material weathered from greenstone. The larger bodies are underlain by greenstone bedrock, an altered or metamorphosed rock. Relief is undulating or gently rolling, and some areas are benchlike. Surface drainage is slow. Plant roots go to a depth of 50 inches in many places. The soil is free of soluble salts and alkali and somewhat resembles Keating loam.

Profile description.—The surface soil, about 10 inches deep, is light brownish-gray to brown friable loam of low organic content and neutral reaction. It is faintly vesicular to a depth of 2 inches, and many stones are scattered over the surface.

The subsoil between 10 and 20 inches is brown rather tough compact irregularly prismatic clay loam containing many rock fragments. Between 20 and 30 inches it is brown or pale-brown rather gritty heavy loam containing many angular and subangular rock fragments. Abruptly replacing this is a 12-inch layer of pale-brown or light brownish-gray compact or very weakly cemented hardpanlike loam that contains many rock fragments. This layer is variegated with

rust brown and grayish brown, and it may occur anywhere between 20 and 40 inches from the surface.

Below the hardpanlike layer the material consists of rock fragments and light yellowish-brown to brown loam between the fragments. The quantity of stone increases with depth, and at about 5 to 10 feet the material grades into greenstone or basalt bedrock. The parent material of this soil is in places partly colluvial or alluvial and in some areas includes weathered granite.

Use and management.—This phase is almost entirely in native grass and sagebrush. It is used for grazing and is average or better for that use.

Ruckles stony loam, eroded steep phase (25–45% slopes) (RN).—This soil is stonier and has more rock outcrops than the eroded steep phase of Ruckles loam, but it is otherwise similar. It usually occurs along ravines and steep breaks below high benches where surface drainage is very rapid. Probably half of the surface soil has been lost through sheet erosion brought on by overgrazing, and in places there are a few shallow gullies. The grazing value is low, and grazing should be rigidly controlled to reduce further erosion.

SALISBURY SERIES

Soils of the Salisbury series have developed over old fluviatile or outwash deposits on high dissected terraces or alluvial fans. Development was under a cover of grass and big sagebrush where the annual precipitation of 13 to 15 inches includes considerable snow. Salisbury soils have the most strongly defined profile layers and are probably the oldest soils in the Baker area. They resemble Hutchinson soils but are calcareous and more compact in the subsoil. Hutchinson soils are noncalcareous. Salisbury soils frequently occur over argillitic and other metamorphic rock materials, whereas Hutchinson soils are usually formed over granitic material. Also, the Salisbury soils are generally more stony or gravelly and less productive.

Salisbury gravelly loam (2–12% slopes) (SA).—This rather dark gravelly well-drained soil with an indurated hardpan developed from old rather coarse-textured water-laid deposits. Although these deposits were derived mostly from argillitic rock materials or soils formed thereon, much basaltic material and some granitic and other metamorphic rock materials are included. Relief is rolling or undulating. The larger areas are south of Baker and are associated with Salisbury stony loam and Rough broken and stony land. Surface drainage is slow to medium, but internal drainage through the hardpan is very slow. The water-holding capacity is low because of the thin soil above the impermeable hardpan. Water penetrates the hardpan very slowly, and plant roots stop at its upper surface.

Profile description.—The surface 8 inches is dark-gray to dark grayish-brown neutral friable fine granular gravelly loam. It is root-bound in virgin areas and has a moderate organic-matter content. This layer is very dark gray or very dark grayish brown when moist. The coarse material in it consists of rounded gravel and rounded and subangular cobblestones and stones.

The upper subsoil from 8 to about 14 inches is brown or slightly reddish brown neutral very compact prismatic gravelly clay. This

layer is tough, dense, and difficult to penetrate with a crowbar. It breaks into small vertical prisms very hard to crumble. A vitreous coating covers the aggregates in many places. This layer is more reddish brown in moist freshly cut exposures. It passes downward into a variegated brown and very pale-brown compact gravelly clay loam in which are imbedded rounded or subangular pebbles. This material is weakly cemented, difficult to penetrate, mildly alkaline, and noncalcareous.

At an average depth of 20 inches is a dense indurated hardpan consisting of cobblestones and pebbles in a matrix of very pale-brown cementing material. This material is extremely difficult to break with a crowbar and rings when struck. It is moderately or strongly alkaline and slightly calcareous. The hardpan is 20 to 40 inches thick and is underlain by light yellowish-brown or brownish-yellow old stratified alluvium consisting of cobblestones, gravel, sandy loams, and finer materials.

Use and management.—Salisbury gravelly loam is used principally for grazing, for which it is best suited. Overgrazing has caused the loss of some surface soil. Because it is located on high wind-swept terraces, the soil is somewhat susceptible to wind erosion. A few acres are cultivated to grains and hay, but yields are low.

Salisbury stony loam (2–12% slopes) (Sc).—Except for its greater content of cobblestones and larger stones and less pronounced soil development, this soil resembles Salisbury gravelly loam. It occurs on deeply dissected high benches. Though the soil is well drained, internal drainage through the hardpan is very slow. The hardpan is rather impermeable to both roots and water. The soil has a low water-holding capacity.

Profile description.—The surface soil is dark-gray to dark grayish-brown neutral loam containing many cobblestones, stones, and pebbles. Many rounded and subangular stones and cobblestones are strewn over the surface, and the soil is very dark gray when moist.

The upper subsoil, between depths of about 8 and 14 inches, is brown or slightly reddish-brown very compact clay or clay loam containing many imbedded stones, cobblestones, and pebbles. This material is about neutral in reaction and breaks into elongated aggregates very hard to crumble. It passes downward into a layer of variegated brown and very pale-brown compact clay or clay loam that varies in thickness and in which many cobblestones, stones, and pebbles are imbedded.

At an average depth of 24 inches the layer just described is abruptly underlain by a hardpan consisting of cobblestones and pebbles cemented with very pale-brown interstitial material. This hardpan is moderately or strongly alkaline and in many places calcareous. It is 1 to 3 feet thick and is underlain by stratified layers of coarse alluvium and more clayey materials containing many cobblestones and pebbles.

In this soil the depth to the hardpan ranges from 10 inches to 3 feet or more, and there is a corresponding variation in the thickness of the different soil layers.

Use and management.—Salisbury stony loam is used entirely for range pasture, for it is too stony and unproductive to cultivate. It has been considerably eroded because of overgrazing.

SPRINGDALE SERIES

Soils of the Springdale series are light colored and have a loose very porous gravelly lower subsoil and substratum. They are lighter colored than the Langrell soils and show little or no differentiation in texture and structure of subsoil layers. They formed from stratified sandy loams and coarse-textured alluvial materials on gently sloping alluvial fans or outwash plains. The alluvium is derived mostly from granite and argillite but to some extent from basalt, gabbro, other rock, and the soils formed thereon. In places the upper part of the soil may be influenced by wind-deposited silty material. The soils developed under an annual precipitation ranging from 12 inches at an altitude of 3,500 feet to 20 inches or more at an altitude of 4,500 feet. The natural vegetation varies from a rather open stand of ponderosa pine at the higher altitudes to sagebrush and grass and an occasional ponderosa pine at the lower altitudes (pl. 5, *B*). The soils in the lower areas under a sagebrush-grass cover are variants and not typical of the series.

Springdale fine sandy loam (1–7% slopes) (SE).—The relief for this soil is that representative of sloping outwash plains or alluvial fans, although some areas occur on stream bottom lands. Most areas have a dominant slope of about 3 percent. Surface drainage is slow and internal drainage is rapid. The content of organic matter in the surface soil is moderate to somewhat low. The subsoil, very permeable to roots and water but of low water-holding capacity, is noncalcareous and neutral or slightly acid in all except isolated areas. The soil is free of soluble salts and alkali; it grades into soils with calcareous subsoil along its eastern extension.

Profile description.—The surface soil, about 10 inches deep, consists of grayish-brown, pale-brown, or brown fine sandy loam. This material is very dark grayish-brown or very dark-brown when moist and contains a trace of gravel and a few cobblestones. In general, it is coarser textured on the higher slopes of the fans but progressively finer and more productive toward the lower parts. The soil is slightly or medium acid where the cover is largely pine and nearly neutral where the cover is mainly sagebrush and grass.

The subsoil, between depths of 10 and 20 inches, grades from pale-brown, brown, or grayish-brown sandy loam to a gravelly sandy loam in which there are many cobblestones. The gravel content increases with increase in depth. The material is very friable but stands up fairly well in cut banks. Gradually replacing this layer is coarse gravelly sandy loam or loamy gravel containing large numbers of cobblestones about 3 to 6 inches in diameter. These stones are mostly granite and argillite, but a few are of basalt and other kinds of rock.

The substrata, below 30 inches, are irregularly stratified layers of porous sand, gravel, and small water-worn cobblestones mixed with only a little fine material. The material of the substrata is very loose and porous and does not stand up in cut banks. Because the entire profile of this soil is composed of stratified materials, layers of sand, gravel, or finer materials may be present in any part.

Included with this soil because of small extent are small areas along the eastern or lower border of the main body in Baker Valley and other small areas in Lower Powder Valley. The soils in these areas are not

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typical of the Springdale series; they are included because of small acreage. These included areas have a somewhat calcareous slightly compact subsoil. The surface soil, about 8 inches deep, is light brownish-gray or pale-brown fine sandy loam containing a rather low supply of organic matter. This surface material is noncalcareous and about neutral. It passes into pale-brown noncalcareous slightly compact faintly sticky fine sandy loam.

Between approximate depths of 14 and 20 inches, the subsoil of these included areas is pale-brown or brown slightly compact more or less calcareous sandy loam containing some water-worn cobblestones. This material is more gravelly with increase in depth and at a depth of about 36 inches passes into loose porous gravel and sand that continues down to a depth of 6 feet or more. This gravel-and-sand layer is incoherent and does not stand up in cut banks.

Use and management.—Most of the timber has been cut from Springdale fine sandy loam. About 66 percent of the land is under cultivation. Owing to lack of water and relatively low productivity, some cultivated areas have been allowed to revert to grass. Alfalfa is grown on nearly 50 percent of the cultivated land. The second cutting is generally light because of the shortage of water and the low water-holding capacity of the soil. This soil must be well irrigated if it is to produce good crops. Wind erosion has done some damage, but water erosion has been insignificant because the soil is gently sloping and porous.

Springdale gravelly sandy loam (1–7% slopes) (Sr).—This soil has a surface layer less stony than that of Springdale stony sandy loam but more gravelly and stony than that of Springdale fine sandy loam. It contains enough gravel to interfere with but not enough to prevent cultivation. In relief, drainage, parent material, and natural vegetation, this soil is much like Springdale fine sandy loam, but it occurs more frequently in broad swales or wide drainageways.

Profile description.—The 10-inch surface soil is grayish-brown, brown, or pale-brown gravelly sandy loam of fair to low organic content. Much gravel is scattered on it, and small rounded cobblestones are present in places.

The upper subsoil, between depths of 10 and 15 inches, is pale-brown very friable gravelly sandy loam. After a gradual transition, the upper subsoil is replaced by pale-brown or brown gravelly sandy loam or loamy gravel containing many cobblestones 3 to 10 inches in diameter. This material is very porous and collapses easily in road cuts. The surface soil and subsoil are both generally noncalcareous and neutral to medium acid. The subsoil has a very low water-holding capacity.

The substrata, below 30 inches, are porous beds of partly assorted gravel, sand, and small water-worn stones with which little fine material is mixed.

Use and management.—About 25 percent of Springdale gravelly sandy loam has been cleared for cultivation, but some of this has been allowed to revert to sagebrush and grass. Alfalfa is grown on approximately 40 percent of the cultivated land. Much grass and many weeds are mixed with the alfalfa. Wheat, oats, and rye are the other main crops and are irrigated by spring floodwaters. In late spring and early summer, irrigation water is generally used on soils more

productive than this one. Wind erosion has removed much of the surface soil, but water erosion has done little damage because this soil is porous and has gentle slopes.

Springdale stony sandy loam (1–7% slopes) (Sg).—Shallow swales along small streams and aggraded alluvial or outwash plains with moderate slopes are occupied by this soil. Several areas occur in narrow belts below the Blue Mountains. The soil is associated with other Springdale soils, especially Springdale gravelly sandy loam. The boundary between these two soils is rather indefinite.

The surface soil and subsoil are noncalcareous and slightly acid or neutral. The content of organic matter in the surface soil is moderate. The substratum has a very low water-holding capacity. Near the mountains the natural vegetation is largely an open stand of ponderosa pine and an undergrowth of sagebrush, grass, willows, aspen, cedar, rabbitbrush, and other shrubs. At lower altitudes the growth is small shrubs, grass, and weeds.

Profile description.—The soil is covered with a 1- or 2-inch layer of partly decayed organic material in timbered areas. The surface soil below this organic layer is grayish-brown or dark grayish-brown stony sandy loam containing a large number of rounded stones. This layer goes down to a depth of 8 inches, where it is replaced by material consisting of grayish-brown or pale-brown sandy loam, gravel, and small rounded stones. This continues to a depth of about 18 inches, is very friable, and has a high rock content. Between depths of 18 and 60 inches or more occur beds of very loose and porous yellowish-brown or brownish-yellow partly assorted small rounded stones, gravel, and sand.

Use and management.—Springdale stony sandy loam is too stony and unproductive to cultivate. It is used for pasture and wood lots, to which it is best suited. Because the soil is porous, there has been little erosion. Some areas are being aggraded.

Springdale very fine sandy loam (2–4% slopes) (Sh).—This soil formed on gently sloping alluvial fans and terraces (pl. 5, *C*). Surface drainage is slow and internal drainage is rapid. In most places the soil is slightly acid or neutral and noncalcareous. Pockets of calcareous material occur in the subsoil in places, especially near the eastern border. The soil contains some mica. There is little definite structure in the soil profile. The upper part of the surface soil has a moderate organic content. A thin layer of organic material covers the surface in areas of pine forest; in most places, however, the scattered timber is almost entirely cut. The surface soil contains little rock. The subsoil is fair to low in water-holding capacity.

Profile description.—The surface soil is grayish-brown or brown very fine sandy loam. It is very dark brown when moist, and a trace of gravel usually occurs in the lower part.

The subsoil, between average depths of 12 and 30 inches, is grayish-brown, brown, or pale-brown friable very fine sandy loam in which there is much gravel. As is true for many recent, or young, soils formed from stratified material, the texture at this depth is variable. The layers may be of sandy loam or loam, and rarely, of clay loam.

Below an average depth of 30 inches the material grades into irregularly stratified layers of gravel, sand, and small water-worn cobblestones. The depth of the soil profile to these gravelly layers

ranges from about 20 inches on the higher western borders of the fans to 50 inches on the lower borders.

Associated with this soil in the vicinity of the Nelson placer workings are about 100 acres with a rather dark grayish-brown silt loam surface soil that contains a small quantity of rounded gravel and cobblestones. In these areas the upper subsoil, between average depths of 12 and 28 inches, is brown or yellowish-brown firm clay loam or gritty heavy silt loam. This material is generally almost neutral, but small pockets of calcareous material occur in places. This layer passes into yellowish-brown light clay loam that contains many rounded cobblestones and pebbles.

Below 32 inches the substratum consists of partly assorted beds of yellowish-brown gravel, rounded small stones, and some fine material. The stones are largely of argillite, but a few are of limestone, granite, and other rock.

This included soil occurs near the upper parts of alluvial fans, and dominant slopes range from 3 to 10 percent. Many deep gullies caused by placer mining are in the areas. Probably 70 percent of this included soil is used for cultivated crops, mainly alfalfa, wheat, and oats. Yields are similar to those produced on Springdale very fine sandy loam.

Use and management.—Over 90 percent of Springdale very fine sandy loam is now cultivated under irrigation. Nearly 50 percent of the cleared land is in alfalfa. Wheat, oats, and barley are also grown.

Some barnyard manure and very little commercial fertilizer have been used. The soil should respond well to fertilizer. A good supply of irrigation water is available for most of it early in spring, but water is scarce after the middle of June. Owing to the smooth relief and the permeable nature of the soil, water erosion has been negligible. Wind erosion has been slight.

STANFIELD SERIES

Soil of the Stanfield series has developed on nearly level, poorly drained bottom lands, alluvial fans, and low terraces under an annual precipitation of 9 to 13 inches. The soil has formed from water-laid sediments of mixed geologic origin. The natural vegetation is mostly greasewood and saltgrass, but rabbitbrush is fairly common, and a few clumps of sagebrush grow in some areas. Some wild barley, tall ryegrass, alkali-grass, and tulegrass occur in moist sites. Stanfield soil differs from the related Umapine soils in having stronger hardpan development, and from the Lun soil in having calcareous more alkaline surface soil and a lighter-textured more friable upper subsoil.

Stanfield silt loam (0–2% slopes) (Sk).—Typically this soil is saline and strongly affected by alkali and has a fairly well-defined calcareous very strongly alkaline hardpan in its subsoil. Surface drainage and internal drainage are very slow. The soil has a good water-holding capacity. The surface soil is low in organic matter but free of stones and gravel. Many spots are barren and are covered with a white efflorescence of salts on drying after rains. The subsoil is very slowly permeable to roots and water, and apparently only the roots of alkali-tolerant shrubs such as greasewood are able to penetrate it. Dark rust-brown stains caused by black alkali are common.

Profile description.—The surface soil has three distinct layers. To a depth of 2 inches it is very pale brown or light-gray vesicular silt loam that becomes grayish-brown when moist. In barren areas it is spongelike. The texture ranges from silt loam to loam. Next in profile is about 4 inches of very friable fine platy silt loam similar to the first layer in color. This grades into friable silt loam of similar color that breaks into subangular easily crumbled aggregates. Considering all three layers, the surface soil is very strongly or strongly alkaline and slightly to highly calcareous.

The upper subsoil from 10 to 16 inches is a light-gray or very pale-brown calcareous somewhat compact silt loam, faintly variegated with rust brown and marked with black alkali stains. From about 16 inches down to 27 inches the subsoil is light-gray or white calcareous very strongly alkaline moderately compact silt loam that breaks into hard aggregates.

That part of the lower subsoil between depths of about 27 and 34 inches is light-gray or very pale-brown highly calcareous very strongly alkaline extremely compact loam or clay loam. This material is difficult to penetrate with a crowbar, breaks into angular aggregates, and looks like a lime or alkali hardpan. There are few roots, but fine capillary holes indicate that some fine roots may have penetrated. The depth to this compact layer ranges from 2 to 4 feet or more. In places the soil is friable above this compact layer, and in such areas this layer has a more hardpanlike consistence. The profile is usually of this character where gravelly material is within 40 inches of the surface and the water table is high. Such is the condition in Lower Powder Valley.

The material below the compact layer is light-gray or very pale-brown calcareous moderately compact silt loam or loam containing some segregated white lime, some mica, and occasional black alkali stains. Generally this layer is less compact, less calcareous, and less alkaline with increase in depth, but in places there may be a second or even a third hardpan layer above a depth of 6 feet.

Very pale-brown, light-gray, or light brownish-gray porous alluvium occurs at an average depth of 50 inches but may be at any depth from 3 to 8 feet or more. The alluvium consists of gravel, sand, rounded and subangular cobblestones, and some fine material of diverse geologic origin. Much of the alluvium is from basalt, granite, gabbro, argillite, quartzite, and a variety of other rocks. The alluvium is generally more or less calcareous and is distinctly alkaline. These gravelly substrata continue to a depth of 15 feet or more in most areas. They are usually waterlogged during winter and early spring and remain moist even in dry summers.

Northwest of Richland in Eagle Valley is a small area of a somewhat different soil that was included because of its small extent. This area is marked by symbols on the soil map to show that its substratum is partly diatomite (*7*).

The surface soil of this included area is very pale-brown or light-gray highly calcareous hard silt loam about 6 inches deep. It is grayish brown when moist, strongly to very strongly alkaline, and grades into calcareous silt loam of similar color that generally contains some rust-brown and rust-red mottlings. The lower part of the mottled material breaks with irregular vertical cleavage and is decidedly compact. In places this mottled material may be gray in the lower part.

The subsoil, occurring below a depth of 20 inches, is variable. In places white diatomite impregnated with soluble salts and lime derived from drainage water occurs at this depth. In other places a lime-cemented hardpan about 12 inches thick is at a depth of about 30 inches. This hardpan contains more or less gravel. In many places this part of the profile is underlain by about 3 feet of light brownish-gray waterlogged somewhat compact coarse alluvium. The alluvium rests on beds of white diatomite more than 5 feet thick. The diatomite is consolidated and very hard to penetrate with a shovel or auger, but when dug up and exposed to weathering, it crumbles to a light-gray or white loam. The water table stands at a depth of about 3 or 4 feet.

Use and management.—Stanfield silt loam has such a high content of alkali that practically none of it is cultivated. Small areas are farmed to preserve the symmetry of fields, but crops are poor and spotty. The land is used almost entirely for saltgrass pasture (pl. 6, *A*). In Lower Powder Valley the carrying capacity is somewhat greater than in other areas where ground water is deeper.

This soil is difficult to reclaim from alkali because of its slowly or very slowly permeable subsoil. The grazing value of many areas in Lower Powder Valley has been greatly improved by continued leaching with irrigation water, and nearly all areas in that locality can be greatly improved. An attempt at complete reclamation is not recommended, because it would probably be unprofitable and only partly successful. An application of 500 pounds an acre of sulfur and liberal quantities of manure in connection with continuous leaching will aid in overcoming alkali.

Areas of this soil associated with Lun silt loam northeast of Baker, and other tracts north of North Powder Valley, have hummocky microrelief and a somewhat different aspect, even though the soil itself is essentially the same as in other sites. The ground water is lower in these hummocky areas, and the grazing value is less. Eight acres or more will provide spring and summer grazing for one animal.

The included area underlain by diatomite northwest of Richland is used for saltgrass pasture, and about 4 acres of it will provide one animal unit with all-summer grazing. Ditching has improved drainage in this area, and apparently the salt and alkali content is being slowly diminished by irrigation and drainage. The present pasture is rather unpalatable, but the soil may eventually be suitable for more palatable pasture and hay crops.

TURNBOW SERIES

Soils of the Turnbow series are shallow, stony, and unproductive. They developed in uplands on residuum weathered from serpentine bedrock under a cover principally of grass. The main bodies of Turnbow soils are associated with Brownlee soils, which overlie granite, and Ruckles soils, which overlie basalt or other basic igneous rocks. Turnbow soils are generally noncalcareous, but a thin limy layer is in the lower part in a few places.

Turnbow stony clay (5–25% slopes) (TA).—The relief of this soil is that of rolling or hilly well-dissected rounded hills with V-shaped intervening valleys. Surface drainage is medium to rapid. Internal drainage is slow to very slow, and water penetrates slowly or very slowly. The water-holding capacity is low because the soil is

shallow to bedrock. This soil stands out from others in the area because it is almost completely without sagebrush.

Profile description.—The surface 6 inches is dark-gray stony clay of weakly to moderately defined fine or very fine granular structure. A large quantity of serpentine rock fragments are on and in the soil. When moist the layer is very dark brown or very dark grayish brown; it is sticky and plastic when wet. It is about neutral in reaction, and the organic-matter content is fair.

The subsoil, extending from a depth of about 6 to 15 inches, consists of rock fragments and brown noncalcareous mildly alkaline clay interstitial material. It contains much dark gray and pale-green decomposed rock that increases in quantity with depth.

Between depths of about 15 and 24 inches the material consists largely of dark-gray, green, and grayish-brown partly decomposed serpentine rock fragments and brown mildly to strongly alkaline interstitial clay. In most places this material is noncalcareous and a few fine roots penetrate it. Below 24 inches is weathered serpentine rock. At a depth of about 40 inches is green-marbled relatively unweathered serpentine bedrock. The unaltered rock has a distinctive green color, but weathered surfaces are grayish brown, brown, or yellowish brown. This rock is resistant to weathering.

Included with this soil are small areas at the foot of slopes that have a deeper soil relatively free from stones. These areas have a slight accumulation of lime in the lower subsoil.

Use and management.—Turnbow stony clay has undergone much erosion caused by unrestricted grazing. Most of it has lost more than 25 percent of its surface soil. The land is used only for grazing, and its grazing value is low. Many spots are nearly barren of vegetation. This soil is naturally unproductive.

Turnbow stony clay, eroded phase (5–40% slopes) (TB).—All gullied or severely eroded areas of Turnbow stony clay are in this phase. Except for being shallower and having more rock outcrops, this phase is similar to Turnbow stony clay in profile characteristics. It occurs principally on domelike or rounded ridges cut by V-shaped ravines. Most of the areas are hilly. The grazing value is slightly lower than that of Turnbow stony clay.

UMAPINE SERIES

Soil of the Umapine series has formed on nearly level poorly drained alluvial fans, stream bottom lands, and old lake basins in which an excess of soluble salts and alkali has accumulated. The annual precipitation is 9 to 12 inches. Umapine soil differs from the Stanfield soils mainly in having no cemented layer or only a very weakly cemented layer in the subsoil. It is lighter colored and more affected by salts and alkali than the Baldock soils and typically lacks the layer of volcanic ash and the compact subsoil of the Haines soils.

Umapine silt loam (0–2% slopes) (UA).—This soil formed from water-laid materials of mixed mineralogic origin. It is derived mostly from basalt, granite, argillite, and related rocks. It is associated with Baldock silt loam and Haines silt loam. The surface soil is free of stones and gravel but low in content of organic matter. Owing to the level relief, erosion has been negligible. Surface drainage is slow, and water sometimes stands on the soil early in spring.

Internal drainage is medium and restricted by the rather compact subsoil, but the soil is fairly permeable to roots and water. It has a good water-holding capacity, but the availability of water to plants is seriously affected by salts. Bare salty alkali spots are common, and many areas have a faint hummocky microrelief. The native vegetation consists mostly of saltgrass and some greasewood, rabbitbrush, and other alkali-tolerant plants, and a little sagebrush.

Profile description.—The surface 5 inches is light-gray, light brownish-gray, or pale-yellow generally calcareous strongly or very strongly alkaline silt loam or loam. It is more or less root-bound in virgin areas, platy in the lower part when dry, and grayish brown when moist. In barren areas the upper 2 inches is vesicular. A white efflorescence covers the surface in many places when the soil dries after the moist spring season. From 5 to 15 inches the soil is calcareous very strongly alkaline friable loam or silt loam similar to the first layer in color.

The material between 15 and 30 inches is light brownish-gray or light-gray highly calcareous loam showing many dark rust-brown stains caused by black alkali. It is slightly or moderately compact and in places breaks with faint vertical cleavage into subangular masses and then into very weakly cemented pea-sized aggregates. There are many fine roots and fine channels.

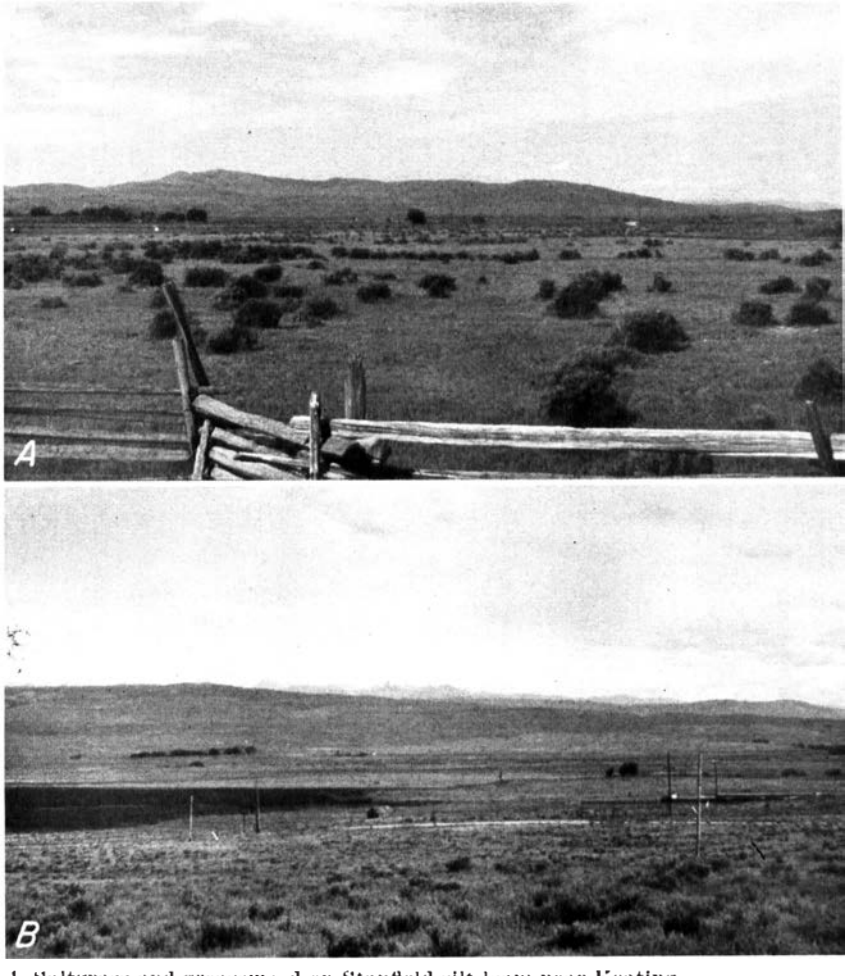
The material between 30 and 44 inches is light-gray or light brownish-gray strongly to very strongly alkaline highly calcareous slightly or moderately compact loam showing many rust-brown and some gray mottlings. Black alkali stains are common, and specks of white segregated lime occur in places. At any depth below 24 inches softly or weakly cemented or nodular layers of pale-brown very strongly alkaline calcareous hardpan a few inches thick may occur. These layers are somewhat compact but can be broken with a shovel. This part of the subsoil is more or less stratified and may include layers of clay loam and sandy loam.

The layer between 44 and 55 inches is light brownish-gray or light-gray friable calcareous loam or very fine sandy loam. North of Baker much of this soil contains a layer of white volcanic ash at this depth (*2*), but such a layer is not common elsewhere.

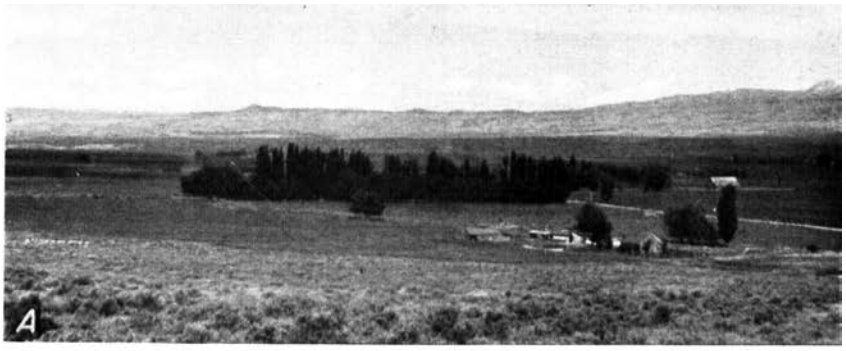
Gray friable clay loam occurs below a depth of 55 to 60 inches in most places. It rests on beds of gray or light brownish-gray sand and gravel in which there are many cobblestones. These beds extend downward to a depth of 15 feet or more. The sandy and gravelly material is mildly alkaline in most places and slightly calcareous to noncalcareous. The depth to these gravelly substrata ranges from 2 to 8 feet or more, and there is a corresponding variation in the thickness of soil layers above. The gravel is generally waterlogged. Some mica occurs throughout the soil.

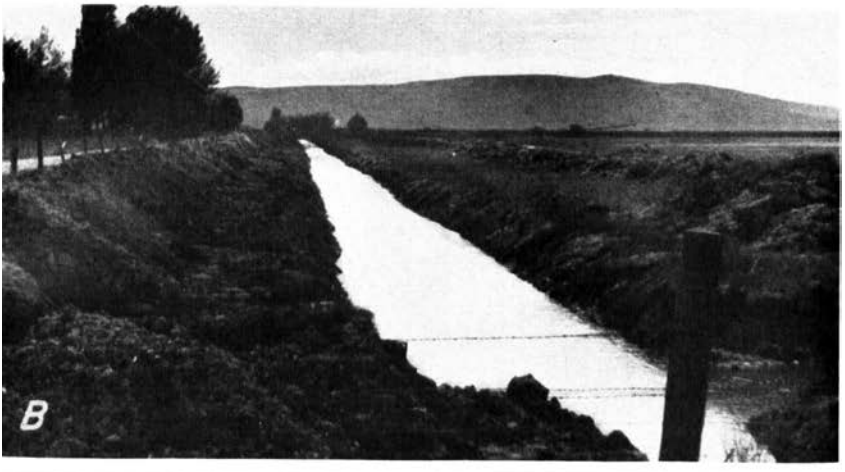
In an area covering about 100 acres southeast of North Powder the soil differs from typical in having a browner surface soil and little or no compactness in the subsoil. Alkali has encroached on this area in recent years, apparently because strongly alkaline water from hot springs has been used for irrigating.

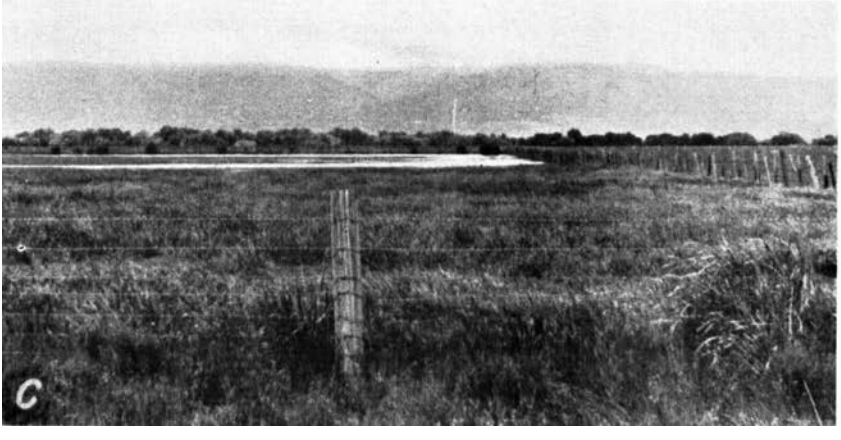
The soil in the areas in Eagle Valley differs from typical in having a higher water table and a much higher grazing value. The soil in those areas is subirrigated and irrigated, and about 2 acres is required to furnish pasture for one cow during the grazing season.



A, Saltgrass and greasewood on Stanfield silt loam near Keating.
B, Landscape in southeastern part of Lower Powder Valley: Big sagebrush, rabbitbrush, cheatgrass, wild barley, and other grasses on Virtue silt loam in foreground; Baker silt loam on low terrace beyond road; Onyx, Powder, and Stanfield soils on valley floor; mainly Keating soils on rolling sagebrush-covered areas beyond valley floor; Wallowa Mountains in far distance.







A, Landscape in southwestern part of Lower Powder Valley: Virtue silt loam in foreground; Baker silt loam on low terrace occupied by nearest ranch buildings; mostly Powder silt loam on valley floor near grove.
B, Drainage ditch in Wingville silty clay loam north of Baker.
C, Grass pasture on Wingville silty clay loam north of Baker.

The soil in an area of about 80 acres north of Haines differs slightly for the typical in having a browner surface soil that is noncalcareous in most places and in having a somewhat heavier textured subsoil. This area is used for grains, bluegrass, and alfalfa.

Use and management.—Most of Umapine silt loam is used for saltgrass pasture. Much of the soil can be reclaimed from salts and alkali if an abundant supply of water is available and deep drainage is feasible. Most of this soil in Baker Valley is difficult to reclaim because the supply of water is scanty and the level relief makes drainage expensive. The salt and alkali content has increased in recent years because water is allowed to evaporate from the surface.

Some of the soil in Lower Powder Valley has been reclaimed by prolonged leaching and drainage, for water is more plentiful and drainage is less difficult in that area. The reclaimed land produces about 3 tons of alfalfa or Ladino clover or 40 bushels of barley an acre under irrigation.

UNDERWOOD SERIES

Soils of the Underwood series have developed in uplands on residuum weathered principally from basalt but in places from andesite, gabbro, or other basic igneous bedrock. Annual precipitation ranges from 20 to 30 inches or more. These soils cover extensive areas, generally at altitudes above 4,500 feet. Relief is mainly hilly or semimountainous, and slopes range from gently sloping to steep.

Underwood soils are associated with and somewhat resemble those of the Rouen series, but they may be distinguished from them by a brown rather than yellowish-brown subsoil and a different kind of underlying bedrock. Underwood soils differ from the associated Mehlhorn soils principally in having a surface covering of forest litter; a less dark, less granular, and more acid surface soil; and a natural forest vegetation.

Underwood loam (2–25% slopes) (Ub).—This well-drained forested soil occupies well-dissected sloping lava benches and is fairly smooth where it is not cut by ravines. The underlying bedrock is resistant to weathering and tends to retain some of the structural relief until completely dissected. Ravines are U-shaped in the lower part and steep near the top of the escarpments. Surface drainage on Underwood loam is slow to rapid and internal drainage is medium. The soil is moderately permeable, and roots normally penetrate to a depth of 5 feet or more. The water-holding capacity of the soil is limited by its shallowness to rock. It is noncalcareous throughout its profile. The natural vegetation is mostly ponderosa pine with some western larch (tamarack), Douglas-fir, white fir, cedar, aspen, willow, chokeberry, elderberry, fern, nettles, mountain-mahogany, and other trees and shrubs.

In the mountainous areas west of Baker small tracts of Rouen soils are included with this one. Around Pine Valley, Underwood loam occurs above the associated and more grass-covered Mehlhorn soils.

Profile description.—In virgin areas the surface is covered with ½ to 1½ inches of organic material consisting of undecayed loose light yellowish-brown pine needles over grayish brown or dark-brown partly decayed needles and leafmold containing many white mycelia.

The organic material overlies a layer about an inch thick of dark grayish-brown or dark-brown slightly or medium acid very friable loam containing considerable organic matter.

The surface soil below the thin layer of loam is brown or dark-brown friable somewhat granular loam to a depth of about 5 inches. This layer is dark brown when moist and is slightly acid to neutral. Many rootlets from shrubs and trees bind the soil into a coherent mass, but the organic content is moderately low. All of the above layers are mixed together in cultivated areas.

The soil between the depths of 5 and 12 inches is brown friable easily crumbled loam. Dark-brown rock fragments occur in this layer.

The above layer grades into a brown or very slightly reddish brown somewhat compact clay loam. This material breaks into small nutlike aggregates, contains some angular rock fragments, and is slightly acid or neutral.

Below a depth of about 24 inches the material is difficult to penetrate with a crowbar because it contains much rock. At this depth there are many grayish-brown and rust-brown spots from weathered basalt. The reaction is slightly acid to neutral.

The material between 35 and 50 inches is yellowish-brown or light-brown clay loam interspersed between fragmental rock. Weathered bedrock is at an average depth of 50 inches. There is a very little rust-brown gritty clay loam in the cracks below this depth. The bedrock may be 1 to 8 feet or more beneath the surface, and there is a corresponding variation in the thickness of the soil layers above it.

There is some variation in this soil. Areas at the foot of slopes have a grayer subsoil than typical because they receive more runoff. Exceedingly rocky areas have a shallower soil than typical and are indicated on the map by rock outcrop symbols. In these areas nearly solid rock with only a little fine material occupying the seams occurs below 24 inches.

Use and management.—The original timber has been removed from Underwood loam, and most of the areas are now covered with second-growth timber. Small plots west of Pine Valley have been cleared and are used for irrigated bluegrass pasture. Much of the soil furnishes scanty grazing early in summer, but it is best suited to the production of timber. There has been very little erosion because the surface has been covered with organic material that has effectively retarded washing.

Underwood loam, steep phase (25–45% slopes) (Uc).—This soil resembles Underwood loam but is steeper, stonier, and more variable in depth. Considerable areas of stony loam are included, and rock outcrops are common. This phase is extensive, and west of Baker Valley it is closely associated with Rouen stony loam. It occupies dissected parts of old lava benches.

This phase is covered with a growth of young timber, and because of the layer of leafmold under the trees, there has been little erosion. None of this soil is cultivated. It is best used for production of timber or wood for farm use.

Underwood stony loam (2–25% slopes) (Ud).—This shallow very rocky soil occurs on forested lava benches. Its relief is benchlike but choppy. Surface drainage is slow to rapid. The surface soil is medium or slightly acid; the subsoil is slightly acid or neutral.

This soil is moderately permeable but has a low water-holding capacity because it is shallow to bedrock. Significant areas of bedrock outcrop are indicated on the soil map by rock outcrop symbols. The natural vegetation is ponderosa pine and some undergrowth of mountain-mahogany, bitterbrush, grass, and flowering plants.

Profile description.—About ½ to 1½ inches of highly organic material is present in virgin areas. Below this and continuing to a depth of about 6 inches is the dark-brown or brown stony loam surface soil. Many basalt stones are on and in the profile.

The upper subsoil to a depth of 12 inches is brown or very slightly reddish brown clay loam containing much weathered basalt. It passes into rocks between which there is slightly lighter or yellower gritty clay loam or loam. This layer is difficult to penetrate with a crowbar because of the large quantity of rock. Below 24 inches the material is nearly solid bedrock, and there is little soil in the seams of the rock.

Use and management.—The soil is too stony to produce good timber but is suitable as a source of the farm wood supply. None of it is cultivated, but it does furnish scant grazing.

VIRTUE SERIES

The Virtue soils have developed from old fluviatile or lacustrine materials. These materials are of diverse origin. Basalt rock appears to be the most common source, but argillite, granite, quartzite, greenstone, and other rock materials are present. In places the upper part of the soil may be influenced by or derived from wind-deposited silts. The annual precipitation ranges from 10 to 13 inches. The most distinctive feature of Virtue soils is a calcareous indurated or strongly cemented hardpan in the lower subsoil. The most typical Virtue soils are on slightly dissected old alluvial fans and terraces, but they may ocur on well-dissected high terraces. Virtue soils are among the most extensive in the area (pl. 6, *B* and 7, *A*). They differ from the Baker soils in having stronger subsoil development.

Virtue silt loam (2–7% slopes) (VE).—This soil occurs on old alluvial fans and terraces in drier parts of the area. Slopes are mainly gentle but some moderate slopes ranging up to 12 percent are included, mostly in the areas used as range land. The natural vegetation is sagebrush and grass, the sagebrush predominating, and some rabbitbrush and many flowering plants (pl. 6, *B*). A few greasewood shrubs occur in places. Cheatgrass is most common, but native perennial grasses are almost as abundant.

Surface drainage is slow to medium, but internal drainage is very slow. As a whole, the soil is very slowly permeable. The upper subsoil of clay retards penetration of water, roots and air, and there is a hardpan almost impervious to roots and water. The water-holding capacity is low because of the compactness of the subsoil.

Profile description.—The surface soil is free of stones and gravel. It may contain many roots but is low in content of organic matter. To an average depth of 12 inches, it is light brownish-gray or pale-brown friable silt loam. In barren areas the first 2 inches is vesicular when dry, and immediately below this the soil is platy. The lower part of the surface soil crushes into weak very fine granules. In some areas the surface soil is a loam or fine sandy loam.

The upper subsoil, between 12 and 20 inches, is pale-brown, brown, or very pale-brown dense tough clay of irregular prismatic structure. It breaks into very hard fine or medium nutlike aggregates showing some gray coating on the fissure planes. The material is brown when moist, difficult to penetrate with a crowbar, and like surface soil, mildly alkaline. It contains many fine roots.

The upper subsoil grades into very pale-brown calcareous slightly compact clay loam or heavy loam in which lime occurs in veins or threadlike patterns. This last-mentioned layer is moderately or strongly alkaline. It breaks into irregular aggregates that are easily reduced to nut-sized subangular aggregates fairly easy to crumble.

At an average depth of 30 inches is a dense rocklike limy very pale-brown and white hardpan stained with brown on the fissure planes. This material is very hard; it rings when struck with a crowbar. It is variable in thickness. The hardest part averages about 9 inches thick and grades into a white or light-gray strongly alkaline calcareous weak hardpan. The weak hardpan generally continues to a depth of 50 to 60 inches, where it rests abruptly on light-gray moderately calcareous loam or sandy loam containing much rounded gravel and many water-worn cobblestones. Very few roots penetrate the hardpan.

Included with this soil because of its similarity and small extent is an area northwest of Sunnyslope School in Baker Valley that has a very fine sandy loam surface soil. Here the surface soil is light brownish-gray or pale-brown very sandy loam. The upper subsoil is very pale-brown compact very fine sandy loam that breaks vertically into angular aggregates containing streaks of white calcareous material. A pinkish-white or very pale-brown weakly-developed highly calcareous hardpan about 2 feet thick occurs at an average depth of 24 inches. The hardpan is underlain by very pale-brown calcareous loamy material containing many pebbles and cobblestones. This soil differs from the typical Virtue silt loam in lacking the pale-brown tough clay upper subsoil. It shows considerable accelerated erosion.

Use and management.—About 75 percent of Virtue silt loam is used for native range pasture, for which it has a value slightly higher than average for the area. The rest of it has been cleared and cultivated at one time or another, but much of its has been abandoned. Probably 15 percent of the soil is now used for cultivated crops, mostly under irrigation. Alfalfa and wheat are the main crops, and yields are much below the average for the Baker area. Irrigation water can be used to better advantage on more friable soils. Where they are dry-farmed, rye or wheat cut for hay produces about ½ ton an acre.

Virtue silt loam, eroded phase (2–7% slopes) (VH).—Although similar to Virtue silt loam, this phase has a surface layer slightly shallower and more irregular in depth. Little of it is severely eroded. Deep gullies are not common, but a few shallow ones have formed. The natural vegetation resembles that on Virtue silt loam. This phase is more extensive than Virtue silt loam in the area east of Baker Valley, but it does not occur in Baker Valley.

Use and management.—In all except a few severely eroded areas, crop yields are slightly lower than on Virtue silt loam. The range land should be protected from overgrazing to reduce erosion and further deterioration of the plant cover. Owing to the shallowness

of this phase, any erosion is injurious. Cultivated areas must be carefully irrigated to prevent erosion.

Virtue silt loam, level phase (0–2% slopes) (VL).—This phase occurs principally in small scattered areas in Lower Powder Valley. The total area is small but all of it is cultivated or partly cultivated. Surface drainage is slow but adequate for irrigation, and the soil is only slightly susceptible to erosion because its slopes are nearly level. This phase differs from Virtue silt loam mostly in having a gentler slope.

Virtue silt loam, sloping phase (7–12% slopes) (VN).—Areas of this phase most often occur at the foot of higher benches. The soil is not appreciably eroded. It is similar to Virtue silt loam but more sloping. The same kinds of crops are grown as on Virtue silt loam, and about the same yields are obtained. This phase should be cultivated on the contour and carefully irrigated to forestall erosion.

Virtue silt loam, eroded sloping phase (7–12% slopes) (VK).—Appreciably eroded areas of Virtue silt loam, sloping phase, make up this phase. It is similar to Virtue silt loam but has a surface soil slightly shallower and more irregular in depth. Most of it shows moderate sheet erosion, but severely eroded areas and deep gullies are rare. A few shallow gullies do occur. The phase generally occupies slopes below higher benches and is somewhat steeper than most cultivated areas of Virtue silt loam.

This phase should be used only for hay and pasture because of the danger of erosion. Cultivation should be only on the contour, and irrigation should be very carefully done in order that erosion may be reduced.

Virtue silt loam, moderately steep phase (12–25% slopes) (VM).—This phase resembles Virtue silt loam but its surface soil is somewhat shallower, stonier, and more gravelly; the upper subsoil is browner; and the hardpan is not so thick nor so hard. Surface drainage is rapid and internal drainage is very slow because of the compact subsoil. The water-holding capacity is low. This phase generally ocupies slopes just below high dissected benches.

Profile description.—The surface soil is light brownish gray or pale-brown silt loam or loam about 9 inches deep. The upper subsoil, between depths of 9 and 16 inches, is brown or pale brown noncalcareous prismatic plastic clay or clay loam. Some rounded cobblestones and gravel are on and in the surface soil and throughout the upper subsoil. The upper subsoil passes into light yellowish-brown or pale-brown loam that grades into a very pale-brown, white, or light-gray calcareous hardpan at a depth of about 24 inches. After the first 9 inches, the hardpan is rather weakly cemented. The substratum, at a depth of 40 or 50 inches, consists of calcareous loam or sandy loam in which there are many cobblestones and pebbles.

Use and management.—This phase is used principally for range pasture and is best suited to that use. It is susceptible to erosion, and nearly 25 percent of its surface soil has been lost in most areas. Overgrazing should be prevented to reduce further erosion.

Virtue silt loam, eroded moderately steep phase (12–25% slopes) (VG).—This phase is similar to the moderately steep phase of Virtue

silt loam, but the surface layer is shallower. It differs from Virtue silt loam in having a surface soil shallower, more irregular in depth, and more cobbly and gravelly. In addition, its upper subsoil is browner and the hardpan is less thick and hard. There has been at least moderate sheet erosion or gullying, but deep gullies are rare. A few areas are severely eroded. The total area is small. This phase is associated with areas of Virtue cobbly loam.

Use and management.—Practically none of this phase is cultivated. Most of it has been badly overgrazed. The soil should be protected from overgrazing if erosion is to be controlled and the density of the range vegetation is to be increased.

Virtue silt loam, deep phase (0–7% slopes) (VF).—This phase differs from Virtue silt loam in having a deeper surface soil, a less heavy and less compact upper subsoil, and a greater depth to calcareous hardpan. It generally occurs on gentle sloping well-drained lower terraces and alluvial fans. Surface drainage is slow to medium but internal drainage is very slow. This phase is associated with Virtue silt loam and Baker silt loam. It may be considered gradational between those two soils, as it has more strongly differentiated profile layers than Baker silt loam and less strongly differentiated ones than the Virtue silt loam.

Profile description.—The surface soil is light brownish-gray or pale-brown silt loam to an average depth of 14 inches, where it passes into pale-brown, brown, or very pale-brown noncalcareous compact heavy clay loam of irregular prismatic structure. This heavy-textured layer is about 10 inches thick and is underlain by very pale-brown or pale-brown somewhat compact loam.

A very pale-brown, white, or light-gray dense calcareous hardpan occurs at about 40 inches, but the depth to this layer ranges from 30 to 60 inches. The denser part of the hardpan is about 10 inches thick, and underneath is a less dense layer about 14 inches thick, which rests on stratified alluvial material.

The soil above the hardpan is rather free of stones and gravel. Plant roots go down to the hardpan. The water-holding capacity is good. The lower subsoil is moderately or strongly alkaline, but the concentration is not strong enough to injure field crops.

Use and management.—Approximately 30 percent of this phase is under cultivation. It is used principally for irrigated alfalfa and wheat. It is a fairly productive soil, and owing to its deeper profile, more productive than Virtue silt loam.

Virtue cobbly loam (2–12% slopes) (VA).—Areas of this soil occur on dissected sloping alluvial fans and terraces where only a few remnants of the original terraces are left. The soil is associated chiefly with the Ruckles and other Virtue soils. Surface drainage is slow to rapid but internal drainage is very slow. The water-holding capacity is limited by the hardpan in the lower subsoil, which is moderately or strongly alkaline but probably not so alkaline that it will interfere with the growth of most crops. The natural vegetation is sagebrush and grass, although sagebrush is reported to have been less common before the area was settled.

Profile description.—The surface soil is light brownish-gray or pale-brown friable neutral or mildly alkaline noncalcareous cobbly

loam to an average depth of about 12 inches. In the virgin condition the upper 2 or 3 inches shows two distinct layers when dry—the first vesicular and the second platy. The lower part of the surface soil breaks into small nut-sized aggregates that are easily crumbled to weak very fine granules. Some rounded cobblestones 2 to 6 inches in diameter are in and strewn over the surface soil. Although there may be many roots, the organic content is low. The surface soil grades into pale-brown or brown friable heavy loam or clay loam that crumbles easily into small nut- and pea-sized aggregates.

The upper subsoil from 16 to 22 inches is pale-brown, brown or very pale-brown tough compact irregularly prismatic clay loam or clay containing many rounded quartzite cobblestones. It passes into somewhat similar material that breaks into irregular aggregates not easily crumbled. The cobblestones, 3- to 6-inches in size, are lime-coated, and streaks of calcareous material follow fissure planes in the interstitial material.

A calcareous hardpan of cobblestones strongly cemented with very pale-brown, light yellowish-brown, and white calcareous material is at a depth of about 30 inches. This hardpan is about 24 inches thick. It is very difficult to penetrate, even with a crowbar, and breaks into irregular horizontal fragments. It is strongly alkaline, and most plant roots stop at its upper surface.

The hardpan rests on very pale-brown, light yellowish-brown, or light gray calcareous loamy material containing rounded cobblestones and some gravel. This loamy layer extends to a depth of 8 feet or more.

Use and management.—Virtue cobbly loam is used for range pasture, for which it is of average value. Only small areas are cultivated because clearing off the cobblestones is too expensive. Crop yields are lower than on Virtue silt loam. Most of the soil is best suited to native pasture. Little irrigation water is available, and the small supply can be used to better advantage on more permeable soils. Overgrazing has caused considerable sheet erosion and occasional shallow gullies.

Virtue cobbly loam, eroded phase (2–12% slopes) (Vc).—This phase shows at least moderate sheet or gully erosion. Except for its shallowness and more irregular depth, it is similar to Virtue cobbly loam. Shallow gullies are common but deep ones are rare. The quartzite cobblestones characteristic of Virtue cobbly loam are very conspicuous in gullied areas. Most of the phase has undergone moderate sheet erosion, but severely eroded areas are not common.

Most of the soil is used for range pasture. It has been badly overgrazed. Grazing should be controlled to allow an increase in the growth and density of grasses and other pasture plants. Some areas may need reseeding to drought-resistant grasses.

Virtue cobbly loam, eroded moderately steep phase (12–25% slopes) (Vb).—This phase shows at least moderate sheet or gully erosion. It occurs along ravines and on hillsides below high benches and includes some steep slopes. It is similar to Virtue cobbly loam but its surface soil is shallower and more irregular in depth. Also, more cobblestones and pebbles are on and in the surface soil, and the hardpan is not so thick nor so hard, because relief is steeper. Severe

erosion is not common, but gullies occur in places. This phase is used for range pasture but it has been badly overgrazed and its present grazing value is low. Overgrazing should be prevented to allow pasture plants a better chance to increase in growth and density. Some of the more eroded areas may need to be reseeded to drought-resistant grasses.

WINGVILLE SERIES

Where drained and irrigated, soils of the Wingville series are among the more productive in the area. They have formed on level or nearly level alluvial fans, stream bottom lands, and old lake bottoms under poor drainage and a cover of grass and few shrubs. The annual precipitation is 10 to 14 inches. The parent material is fairly recent and of diverse geologic origin, but it comes mostly from basalt, other lava rocks, argillite, granite, and related kinds of rock, and soils formed thereon. Wingville soils differ from the related Catherine soils principally in being calcareous. They differ from the related Baldock soils in being darker and less affected by soluble salts and alkali. In Baker and Lower Powder Valleys the lime content of the Wingville soils is variable even in short distances. Wingville soils contain some mica.

Wingville silt loam (0–2% slopes) (WA).—The relief on this dark or very dark soil is nearly level but generally adequate to remove surplus irrigation water if shallow ditches are used to expedite surface drainage. The subsoil is somewhat fine-textured, and water and air penetrate it somewhat slowly. Nonetheless, it has good water-holding capacity, and internal drainage is adequate for most crops. The gravelly substrata are waterlogged in spring and early in summer and furnish moisture for subirrigation. Although mildly or moderately alkaline, the soil generally does not contain excess soluble salts. Some salts occur in the soil where it borders Baldock, Gooch, or other saline soils.

The natural vegetation is mostly bluegrass and other grasses, including a trace of saltgrass, some flowering plants, and a few scattered sagebrush and other shrubs. Flags, tall ryegrass, and tulegrass grow on wet spots, and a few willows, cottonwoods, alders, and haws grow along streams.

Profile description.—Little or no differentiation of textural and structural layers is evident in this soil. The upper part of the surface soil, about 6 inches deep, is dark-gray or very dark-gray friable silt loam. This part is black or very dark gray when moist, root-bound in virgin areas, and crumbly when dry. The lower part of the surface soil is a silt loam similar to the upper part in color. It breaks into subangular easily crumbled aggregates and contains many roots. Considering both parts, the dark surface soil ranges from 10 to 30 inches in thickness but is 18 inches thick on the average. The surface soil in most places is calcareous and mildly or moderately alkaline. It is free of stones and nearly free of gravel. Some mica occurs throughout the entire surface soil.

The subsoil between 18 and 38 inches is light brownish-gray or grayish-brown, friable silt loam or clay loam that breaks into subangular easily crumbled aggregates. It is very dark grayish brown

or very dark gray when moist, contains many fine roots and numerous old root channels, and is calcareous in most places.

The material between 38 and 48 inches is somewhat variable but in most places it is gray, light brownish-gray, or grayish-brown silt loam or clay loam showing some gray and rust-brown mottlings. This material is dark gray or dark grayish brown when moist, breaks into large irregular easily crumbled aggregates, and is generally noncalcareous. In places some gravel or fine sand occurs in the lower part.

Below 48 inches there are beds of grayish-brown, gray, light yellowish-brown, or light olive-gray noncalcareous sand, gravel, rounded cobblestones and finer sediments that apparently extend to a depth of more than 10 feet in most places. The depth to this gravelly layer ranges from 36 to 72 inches or more, and there is a corresponding variation in the thickness of the soil layers above. Areas having less than 36 inches of soil over the gravelly layer are classified as the porous subsoil phase.

There is some variation from the profile described. In places dark-gray or dark grayish-brown buried old surface soils occur in the subsoil, and in other places a thin layer of white volcanic ash occurs in the lower subsoil. Neither of these is typical of Wingville silt loam.

Use and management.—Over 80 percent of Wingville silt loam is under cultivation, and the rest is used for native hay and pasture. Alfalfa, wheat, oats, barley, mixed bluegrass-and-timothy hay, and clover are the main crops. Mixed bluegrass-and-timothy hay average 1¾ tons an acre under irrigation. Small areas in the Lower Powder Valley locality are dry-farmed or farmed with subirrigation only. Alfalfa, wheat, oats, and rye are grown. From 2 to 3 bushels of alfalfa seed an acre are produced in these areas.

Erosion has caused no appreciable damage. The salt content of the soil is apparently increasing slowly in some irrigated areas, and in these drainage should be improved to prevent further accumulation of soluble salts. The moderately high water table is inclined to make alfalfa short-lived.

Wingville silt loam, porous subsoil phase (0–2% slopes) (W$_B$).—This phase differs from Wingville silt loam in having a coarse gravelly material at a shallower depth (generally about 20 inches from the surface) and thinner layers of soil above the gravel. It occurs mostly in narrow belts along small streams and is often flooded after heavy winter rains. Surface drainage is slow, and the porous substrata are water-logged during winter and spring. Some salts or alkali are in the surface soil in places, but not enough to affect most small grains or grasses. The soil is moderately permeable to water. The natural vegetation is mainly bluegrass, saltgrass, other grasses, and a few scattered shrubs and flowering plants.

Profile description.—The surface soil—a dark-gray silt loam or loam—extends to an average depth of 14 inches. This layer is nearly black when moist, generally calcareous and mildly or moderately alkaline, high in organic content, and root-bound in virgin areas. A small quantity of gravel generally is on the surface, but areas with much gravel are shown on the soil map by gravel symbols.

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The subsoil, between 14 and 20 inches, is light brownish-gray, gray, grayish-brown, or light gray friable silt loam or loam containing some gravel in the lower part. It shows traces of rust-brown and gray mottlings and is generally calcareous and mildly to moderately alkaline. This material is underlain by beds of noncalcareous very porous sand, gravel, rounded cobblestones, and finer sediments. The depth of the soil to the gravel ranges from 12 to 36 inches.

Use and management.—About 55 percent of this phase is under cultivation; the rest is used for native pasture. Cultivated areas are used for small grains, bluegrass hay, and some alfalfa under irrigation. The untilled areas are generally irrigated with floodwater in spring and are also subirrigated during the summer. They provide good pasture.

Wingville silty clay loam (0–2% slopes) (Wc).—This soil covers a large total area. It resembles Wingville silt loam in relief, drainage conditions, and mineralogic origin of parent material but differs in that the material is of finer texture. The soil contains enough excess soluble salts to cause injury to crops only in those areas where it borders the Baldock, Gooch, or other saline soils. Surface drainage is slow but adequate where the soil is irrigated and drained (pl. 7, *B*). The subsoil is moderately permeable and has good water-holding capacity. The natural vegetation consists chiefly of grass, including some saltgrass, but there are some flowering plants and a few sagebrush and other shrubs.

Profile description.—The surface soil is dark-gray or gray crumbly platy silty clay loam to a depth of 6 inches; below this to 18 inches it is silty clay loam of similar or slightly lighter color. The dark surface soil ranges from 12 to 30 inches in depth and is black or very dark gray when moist, sticky when wet, and fairly friable when dry. It is free of stones and gravel.

The subsoil between 18 and 36 inches is gray, light-gray, or light brownish-gray firm silty clay loam or clay loam, which breaks into large subangular aggregates that crumble easily when dry. The surface soil and upper subsoil are mildly to moderately alkaline and generally calcareous.

The material between 3 and 5 feet is variable but generally light-gray or gray somewhat mottled friable silty clay loam or clay loam containing some gravel in the lower part. It is less calcareous than the overlying layer and generally is mildly alkaline. It rests on beds of light-gray, gray, grayish-brown, or light olive-brown gravel, cobblestones, and fine sediments that are generally noncalcareous and mildly alkaline or neutral.

Use and management.—Over 80 percent of Wingville silty clay loam is under cultivation. The cultivated land is used mainly for alfalfa, wheat, barley, oats, mixed bluegrass and timothy, and clover; the rest is used principally for pasture (pl. 7, *C*). Bluegrass mixed with timothy or clover produces 1¾ tons an acre under irrigation.

Deposition has probably exceeded erosion on this soil. The drainage on some areas should be improved to prevent the accumulation of salts.

Wingville silty clay loam, gravelly subsoil phase (0–2% slopes) (Wd).—This phase differs from Wingville silty clay loam principally

in having the coarse gravelly material at a shallower depth. As a result it is more permeable to water and has a lower water-holding capacity. The soil occurs in small scattered bodies, mainly near channels of small streams. Relief is nearly level. The surface soil and subsoil are generally moderately or strongly alkaline but range from mildly to strongly alkaline. The gravelly substratum is slightly calcareous in the upper part but less calcareous with increasing depth. The natural vegetation is largely saltgrass.

Profile description.—The surface soil is dark-gray or gray calcareous silty clay loam or clay loam that extends to a depth of about 10 inches, where it passes into calcareous gray, light-gray, or light brownish-gray clay loam that may contain a little imbedded gravel. Stratified beds of gravelly loam, gravel, and sand begin at an average depth of 24 inches and apparently extend to a depth of 8 feet or more. The depth to the gravel ranges from 14 to 36 inches, and there is corresponding variation in the thickness of the soil layers above.

Use and management.—About 35 percent of this is cultivated. Average yields are lower than on Wingville silty clay loam. The uncultivated soil is used mostly for saltgrass pasture.

ESTIMATED YIELDS

Average acre yields of grain and pasture crops that can be reasonably expected over a period of years under the management currently practiced are given in table 5. These estimates were made after interviews with farmers and the checking of average yield statements on file at the county agent's office. (Farmers had submitted these statements to the Agricultural Adjustment Administration, now the Production and Marketing Administration.) Actual records of yields by soil types were not generally available, and data for yields of hay crops and pasture were particularly meager.

TABLE 5.—*Average acre yields of principal crops to be expected under prevailing management on soils of the Baker area, Oreg*

[In columns IR—yields under irrigation. In columns DR—yields under dry farming on land fallowed the previous year. Blank spaces indicate crop ordinarily is not grown on the soil or is not produced under the method specified. For information on prevailing use and management of a particular soil and its crop suitabilities and limitations, see the section on Soil Descriptions.]

Soil	Wheat		Barley		Oats		Rye		Corn	Alfalfa		Clover	Native hay	Pasture (under range conditions)
	IR	DR	IR	DR	IR	DR	DR	DR	IR	IR	DR	IR	IR	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per cow month* [1]
Applegate clay loam	25		25		35		13			2.0		1.5		3.5
Hilly phase													1.3	5.0
Baker silt loam:														
Normal [2]	25		27		32					2.0				4.0
In Eagle Valley	30		38		45				50	[3]4.25		2.0		4.0
Coarse-textured subsoil phase.	28		35		36					2.0				4.0
Eroded hilly phase														7.0
Eroded phase														6.0
Hilly phase										1.0				5.0
Level phase:														
Normal [2]	26		28		33					2.25				4.0
In Eagle Valley	31		40		47				52	[3]4.25		2.0		4.0
Sloping phase:														
Normal [2]	24		26		31					2.0				4.0
In Eagle Valley	29		37		44				48	[3]4.0		2.0		4.0
Baldock loam	26		33		35					2.5			1.25	.8
Gravelly subsoil phase	20		25		30					2.0			1.1	1.0
Baldock silt loam	28		33		35					2.5			1.25	.8

Balm gravelly sandy loam														.5
Balm loam	[4] 20		[4] 30		[4] 35								1.5	.5
Barnard clay loam	25		33		37				50	[3] 3.5		2.0		4.0
Eroded hilly phase														6.0
Eroded phase														6.0
Hilly phase	[5] 20				[5] 30					[3 5] 2.0		2.0		5.0
Brownlee loam	[5] 24	[5] 15	[5] 33	[5] 20	[5] 35	[5] 18	[5] 8	[5] 1.2		[5] 2.0	[5] 1.5	[5] 1.5		5.0
Eroded phase	[5] 22	[5] 13	[5] 30	[5] 18	[5] 32	[5] 16	[5] 7	[5] 1.2		[5] 2.0	[5] 1.5	[5] 1.4		6.0
Eroded shallow phase														9.0
Eroded steep phase														12.0
Shallow phase														7.0
Bulger silt loam	25		33		37					2.5				3.0
Catherine loam	34	19	35		40					3.5	2.0		1.75	.7
Catherine silt loam:														
In Eagle Valley	30		35		40				50	[3] 5.0		2.0		.5
In Sumpter Valley					60									.5
In Baker Valley	30	15	35		40					3.5	2.0	2.7		.5
Catherine silty clay loam:														
In Sumpter Valley					50									.5
In Baker Valley	30	15	35		40			1.5		3.5	2.0	2.7	1.0	.5
Gravelly subsoil phase	28		32		36					3.0		2.5		.5
Overwash phase										[4] 3.0				.3
Clover Creek loam		14									1.5			4.0
Clover Creek stony loam														5.5
Durkee stony clay loam														4.0
Eroded phase														5.0
Eroded steep phase														8.0
Steep phase														7.0
Gem clay	[6] 20	[6] 9	[6] 30		[6] 30	[6] 12	[6] 7			[6] 2.0	[6] 1.0	[6] 1.2		3.0
Eroded phase														5.0
Eroded steep phase														8.0
Steep phase														7.0
Glasgow silt loam	20	10	34	12	35					2.0	1.0			4.0
Eroded hilly phase														8.0
Eroded phase	[6] 16	[6] 7	[6] 27	[6] 9	[6] 27					[6] 1.5	[6] 0.8			5.0
Gently sloping phase	20	10	34	12	35					2.0	1.0			4.0
Hilly phase														6.0

See footnotes at end of table.

TABLE 5.—*Average acre yields of principal crops to be expected under prevailing management on soils of the Baker area, Oregon*—Continued

Soil	Wheat		Barley		Oats		Rye		Corn	Alfalfa		Clover	Native hay	Pasture (under range conditions)
	IR	DR	IR	DR	IR	DR	DR	DR	IR	IR	DR	IR	IR	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per cow month* [1]
Glasgow stony loam														6.0
Eroded hilly phase														8.0
Eroded phase														7.0
Eroded steep phase														12.0
Hilly phase														7.0
Steep phase														10.0
Glasgow stony soils														25.0
Gooch silt loam	15		27							1.5			1.25	1.0
Gooch silty clay loam	26		35							2.0			1.3	.6
Alkali phase	20		28							2.0			1.1	1.0
Gravel pits														
Haines silt loam			20							1.0			0.8	1.0
Halfway clay:														
Normal [2]	30		44		47							2.5	1.5	.5
With gravel symbols													1.3	.6
Halfway clay loam	32		45		48					3.75		2.5	1.5	.5
Halfway silt loam	30		44		47							2.25	1.5	.5
Hershal silt loam													1.3	.5
Gravelly subsoil phase					47					1.5		1.5	.9	.5
Hibbard clay	22	14			30					1.75				3.0
Eroded moderately steep phase														6.0

Moderately steep phase														5.0
Eroded phase														5.0
Hibbard clay loam	26									2.0				3.0
Eroded phase										1.75				4.0
Hibbard silt loam	27	17						1.25		2.0			1.25	3.0
Eroded phase														4.0
Hilly phase														4.0
Hibbard stony clay														5.0
Eroded moderately steep phase														7.0
Eroded phase														6.0
Eroded steep phase														8.0
Moderately steep phase														6.0
Hutchinson loam	25	16	30		35					2.0				3.0
Shallow phase	20	14								1.75				3.5
Keating loam	21	13	33		34	20	9	1.0		2.5	1.5	1.5		4.0
Deep phase	25	17	35		37	22	9	1.2		2.6	1.5	1.6		4.0
Eroded hilly phase														5.0
Eroded steep phase														6.0
Gently sloping phase	21	13	33		34	20	9	1.0		2.5	1.5	1.5		4.0
Hilly phase	[5] 20	[5] 12	[5] 31		[5] 32	[5] 19	[5] 9	[5] 1.0		[5] 2.0	[5] 1.3	[5] 1.5		4.0
Keating stony loam														5.0
Eroded phase														6.0
Eroded steep phase														12.0
Gently sloping phase														4.0
Sloping phase														5.0
Steep phase														10.0
Kilmerque loam	20	12			30		9	1.0		2.0				6.0
Hilly phase														7.0
Kilmerque sandy loam							12							10.0
Eroded steep phase														12.0
Hilly phase														11.0
Ladd loam	25	17			40					2.0				2.5
Alluvial-fan phase	33		38		43					3.5				2.0
Deep phase	26	17			40					2.0				2.0
Hilly phase														3.0

See footnote at end of table.

TABLE 5.—*Average acre yields of principal crops to be expected under prevailing management on soils of the Baker area, Oregon*—Continued

Soil	Wheat		Barley		Oats		Rye		Corn	Alfalfa		Clover	Native hay	Pasture (under range conditions)
	IR	DR	IR	DR	IR	DR	DR	DR	IR	IR	DR	IR	IR	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per cow month* [1]
Langrell gravelly loam:														
Normal [2]	20				30				45	2.0		2.0		1.0
With stone symbols														1.0
Langrell loam	30		45		50				50	3.5		2.0		1.0
Lookout clay loam	24	10	30		35		8	1.0		[4] 3.0		1.5		4.0
Eroded hilly phase														6.0
Eroded phase														5.0
Hilly phase	[5] 22	[5] 10			[5] 32		[5] 6	[5] 1.0		[3 5] 2.0		[5] 1.3		5.0
Lookout stony clay loam														5.0
Eroded phase														6.0
Eroded hilly phase														7.0
Hilly phase														6.0
Lun silt loam														10.0
McEwen loam			35		55					1.5				6.0
Deep phase			35		60					1.5				5.0
Moderately steep phase														8.0
Overwash phase					48									1.0
Mehlhorn clay loam	22									2.5				4.5
Hilly phase														7.0
Mehlhorn stony clay loam														7.0
Eroded hilly phase														9.0
Eroded phase														8.0

Eroded shallow phase														10.0
Eroded steep phase														12.0
Hilly phase														8.0
Moscow loam														10.0
Eroded phase														11.0
Eroded steep phase														13.0
Steep phase														12.0
Muck														.5
North Powder loam	[6] 18	[6] 9			[6] 25		[6] 8	[6] 1.0		[6] 2.0		[6] 1.3		4.0
Eroded hilly phase														7.0
Eroded phase														5.0
Eroded shallow phase:														
Normal [3]														6.0
With stone symbols														7.0
Onyx silt loam	28	15	35		40		10	1.5		3.5	1.5			2.5
Alluvial-fan phase	36	18	40		45					4.0				2.0
Eroded alluvial-fan phase	33	16	36		40					3.5				2.0
Gravelly subsoil phase	25	14	30		35					2.5				2.5
Placer diggings														
Powder silt loam	28	15	35		40		10	1.5		3.5				3.5
Riverwash														
Rouen stony loam														10.0
Steep phase														12.0
Rough broken and stony land														25.0
Ruckles loam	[6] 14	[6] 7			[6] 28		[6] 7	[6] 1.0		[6] 2.0		[6] 1.2		4.0
Deep phase	[6] 15	[6] 8			[6] 30		[6] 8	[6] 1.0		[6] 2.0		[6] 1.2		4.0
Eroded hilly phase														6.0
Eroded phase	[6] 12	[6] 6			[6] 22		[6] 6	[6] 1.0		[6] 2.0		[6] 1.2		5.0
Eroded steep phase														8.0
Hilly phase	[6] [6] 12	[6] [6] 6					[6] [6] 6							5.0
Steep phase														7.0
Ruckles stony loam, eroded steep phase														9.0
Salisbury gravelly loam	17									1.5				3.5
Salisbury stony loam														4.0
Springdale fine sandy loam	20				30		9			2.0				3.0

See footnotes at end of table.

TABLE 5.—*Average acre yields of principal crops to be expected under prevailing management on soils of the Baker area, Oregon*—Continued

Soil	Wheat		Barley		Oats		Rye		Corn	Alfalfa		Clover	Native hay	Pasture (under range conditions)
	IR	DR	IR	DR	IR	DR	DR	DR	IR	IR	DR	IR	IR	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per cow month* [1]
Springdale gravelly sandy loam	13				23		8			1. 25				4. 0
Springdale stony sandy loam														5. 0
Springdale very fine sandy loam	31		35		38		13			3. 5				3. 0
Stanfield silt loam													.8	1. 5
Turnbow stony clay														6. 0
Eroded phase														7. 0
Umapine silt loam													.7	1. 25
Underwood loam:														
Normal [2]					30					1. 3				8. 0
With rock outcrop symbols														12. 0
Steep phase														10. 0
Underwood stony loam														12. 0
Virtue cobbly loam														4. 0
Eroded moderately steep phase														7. 0
Eroded phase														5. 0

Virtue silt loam	18	8			30			.5		1.75				4.0
Deep phase	24	10			35			.6		2.25				3.5
Eroded moderately steep phase														6.0
Eroded phase	17	7			28			.5		1.75				5.0
Eroded sloping phase	14	6			25			.4		1.4				5.0
Level phase	19	9			32			.6		2.0				4.0
Moderately steep phase														5.0
Sloping phase	18	8			30			.5		1.75				4.0
Wingville silt loam	30	15	35		40	25	10			3.5	1.2	2.25	1.0	.5
Porous subsoil phase	22		30		33					1.75			1.0	.6
Wingville silty clay loam	30	15	35		40			1.5		3.5	2.0	2.7	1.0	.5
Gravelly subsoil phase	28		32		36					3.0			1.0	.5

[1] Acres-per-cow-month, used to express the carrying capacity of pasture land, is the number of acres necessary to carry 1 cow or mature steer for a month. The grazing season in the Baker area is usually 5 months, and the annual carrying capacity of a soil is therefore obtained by multiplying its monthly capacity by 5. For example, if 2 acres of a given soil will carry 1 cow for a month, the number of acres of that soil required to carry 1 cow for the grazing season will be 5 times 2 acres, or 10 acres.

[2] The soil as it normally occurs in most areas.
[3] Total yield in three cuttings.
[4] Yield in better drained areas.
[5] Yield in less sloping areas.
[6] Soil is ordinarily not cultivated.

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Much difference of opinion prevails as to the grazing capacity of range land. The ranchers generally report the highest grazing capacities. The Forest Service, the Grazing Service, and the Soil Conservation Service have made studies of grazing capacities of range lands in the area. Consideration was given to all available data in estimating the grazing capacity of the various soils, but perhaps most weight was given to the Forest Service data, as that agency has made intensive studies of the grazing capacity of range land for a period of more than 25 years.

The yields given in table 5 are average acre yields that are likely to be obtained by using the common farming practices of the area. Such common practices do not include application of commercial fertilizer, and little manure is applied. For the irrigated crops, yields are assumed to be those obtained when irrigation water is available for grains until about June 1, and for alfalfa until about July 1. Crops grown by dry-farming are assumed to be on land fallowed the previous year. The grazing capacity is assumed to be under range conditions and is stated as soil acres a cow month (SA/CM), the standard locally used by the Forest Service and the Grazing Service. The figure given in the table is the estimated number of acres required to furnish pasture for one cow or mature steer for one month.

The average expectable yields given in table 5 will not be obtained every year, because weather differs from year to year. Also, the yields cannot be expected on every farm or field, for management practices differ from farm to farm and the productivity of each soil shows some variation.

The productivity of land is influenced mainly by climate, the soil (including drainage and relief), and management. No one of these factors operates separately from the others. Crop yields over a long period of years are used as evidence of productivity wherever available. Nonetheless, crop yields will vary according to the kind of management the soil receives. Some farmers will consistently get higher yields than those given in table 5 because they use soil management practices and systems of cropping more efficient than usual. Others who are not managing their soils so efficiently will get lower yields.

The farmer can use the yields shown in table 5 to determine how good or how poor a job he is doing. By learning the names of the soils on his farm and then finding out what average yields farmers in the Baker area are likely to obtain according to past experience, a farmer can compare his own yields with those considered average for his soils. If, on the average, his yields fall very far short of those given in table 5, he may conclude his management practices are responsible, and that a change in management may increase yields.

SOLUBLE SALTS AND ALKALI IN SOILS

The soluble salts most common in soils of the Baker area are chlorides, sulfates, and carbonates of sodium, and to a lesser extent, chlorides and sulfates of magnesium and calcium. The excess soluble salts not distinctly alkaline are sometimes called white alkali because of the white efflorescence they form on the soil when dry. White alkali consists of neutral or slightly alkaline salts—mostly sodium

chloride, sodium sulfate, and magnesium sulfate—and does not have a corrosive effect on plants nor a high deflocculating action on soils.

Alkali soils are caused by adsorption of sodium from the soluble salts onto soil colloids. When salts are leached from an alkali soil the adsorbed sodium disperses the soil colloids. The organic colloids also disperse and often create a characteristic dark-brown or black stain on the soil surface that has given rise to the local term "black alkali." When colloidal dispersion takes place the soil becomes almost impermeable to water and air, and plants survive with difficulty or die. Reclamation is difficult and involves the use of chemical amendments, organic supplements, and careful management of water and tillage. Drainage is essential.

A number of factors have contributed to the accumulation of salts and alkali in some of the soils in this area. The rainfall is low, and therefore less soluble salts are leached from the soil. Other factors contributing to salt and alkali content are (1) the high rate of evaporation and the capillary rise of water from a high water table, (2) poor drainage, and (3) the accumulation of soluble mineral products weathered from rocks and brought in by water flowing from higher elevations. Many hot springs in Baker Valley have contributed large quantities of very strongly alkaline salts to poorly drained and irrigated soils.

Field indications of salt and alkali content in soils, such as the amount and kind of vegetation, the color and structure of the soil, and the presence of crusts of salts on the surface, are verified by the electrolytic salt bridge and pH determinations made in the field and laboratory. The reaction, or pH value, is indicative of the concentration of salts and alkali. All soils in the Baker area containing harmful accumulations of soluble salts or alkali are strongly alkaline in reaction and have a pH of 8.5 or above. On the basis of all information, soils are separated according to different degrees of salt and alkali content.

Areas strongly affected by salts and alkali generally have a cover of salt-tolerant plants, principally saltgrass, alkali-grass, and wild barley. In some places the surface concentration of both neutral and alkaline salts is high enough to prevent growth of any vegetation. Such areas may have a smooth hard salt-crusted surface or a fluffy spongelike appearance. Where exchangeable sodium is present, the soil may be deflocculated and its subsoil may be dense or compact and very slowly pentrated by roots and water.

Some soils have little if any excess soluble salts in their surface soil but, nonetheless, a high content of such salts in their subsoil. Areas of this kind may support a good stand of sagebrush and grass because the surface soil permits thrifty growth.

The strongly alkaline soils of the Baker area include the Stanfield and Haines soils and many areas of the Umapine soil. They have a high content of salts, a strongly or very strongly alkaline reaction, and invariably contain exchangeable sodium.

Soils moderately affected by salts or alkali usually have a better vegetative cover and better structure than those strongly affected. They may or may not contain salts or alkali in their surface soil. Umapine soil in many places is characterized by moderate content of salts and alkali, as are some areas of the Gooch and Baldock soils.

Certain areas of the Baldock, Powder, and Balm soils have only a slight content of salts. Crops do fairly well on these areas, but care must be exercised in controlling moisture conditions, and sufficient water must be applied to keep the salts and alkali below the root zone.

Salts may also occur in areas in soils normally free of soluble salts, as for example, in the Wingville soils. There may be a few saline areas included in these soils where they border soils containing appreciable quantities of salts. The included areas are indicated on the map by salt and alkali symbols. The noncalcareous soils, as for example the Catherine, Onyx, and Halfway, are free of injurions quantities of salts.

Reclaiming a saline or alkali area requires consideration of (1) concentration of soluble salts; (2) drainage conditions; (3) composition of the irrigation water; (4) presence of lime or gypsum in the soil; and (5) content of exchangeable sodium in the soil (*5*).

Total content of salts in a soil does not always determine the feasibility of reclamation and use. Even if the salts are removed, such factors as poor soil structure and dense highly dispersed subsoil may persist and limit yields. For example, heavy-textured soils and those having dense claypans, hardpans, or compact subsoil layers are difficult to reclaim because these layers restrict penetration of water, and consequently the rate of percolation is so slow as to prevent effective leaching of the soluble salts. The cost of reclaiming such soils is usually so high as to be almost prohibitive. In general, soils with a high content of exchangeable sodium, poor drainage, and a dense subsoil are exceptionally difficult to reclaim. Stanfield soil is in this category.

Soils that contain soluble salts and have a subsoil not too dense or too high in exchangeable sodium can be reclaimed readily but require improved drainage and gypsum or sulfur. When calcium from gypsum or from the action of sulfur has replaced the exchangeable sodium, the soil may be leached by copious irrigation. The quantity of gypsum or sulfur required depends on the exchangeable sodium content. Reclaiming an acre-foot of soil (4,000,000 pounds) requires 0.32 ton of sulfur or 1.7 tons of gypsum for each milliequivalent (m. e.) of exchangeable sodium per 100 grams of soil (*11*).

Soils having a slight content of salts generally can be reclaimed and used for general agriculture if conditions of drainage and calcium saturation are favorable. Some soils in Lower Powder Valley have been partly reclaimed by alternate leaching and drying.

The irrigation water in Lower Powder Valley is well suited to the reclamation of alkali soils because it contains a moderate content of soluble salts. The use of pure water on salty or highly calcareous soils causes a rapid rise in pH, which in turn causes the soil to deflocculate, or "freeze up" as farmers say, and become relatively impervious to moisture.

IRRIGATION AND WATER SUPPLY

In the Baker area irrigation is generally necessary for successful production of crops where the annual precipitation is less than 12 or 13 inches. Precipitation is closely related to altitude, direction and distance from high mountains, and air drainage, or wind cur-

rents. Generally, the precipitation increases irregularly with increasing altitude. Eagle Valley, with average altitude of 2,200 feet, has strong air drainage and an annual precipitation of 9 to 10 inches. Pine Valley, surrounded by mountains and with limited air drainage, is only about 10 miles from and slightly higher than Eagle Valley but has an annual precipitation of over 17 inches.

As in most parts of the West, the water supply is not adequate to irrigate all the land available. The shortage of water has been the cause of much litigation. Eagle Valley has an ample supply of water from Eagle Creek. A dependable supply of water for the irrigated parts of Lower Powder Valley is furnished by Thief Valley Dam, completed in 1932. This dam has a reservoir capacity of 17,400 acre feet.

The irrigation water for Baker Valley comes from the Powder River and a number of smaller streams heading in the Blue Mountains. These streams provide much floodwater in early spring and a diminishing supply until July, after which time water is relatively scarce. Much water in the Powder River goes to waste during winter. The erection of dams above Baker to conserve this water has been proposed various times, but this has been discouraged by high estimated costs and other objections.

Water of good quality for stock is obtained almost entirely from irrigation ditches in the irrigated areas. Stock water on the range has been scarce after the subsiding of spring freshets, but this shortage has been partly overcome in recent years by building dams and drilling wells. On farms near the foothills domestic water of excellent quality is obtained from springs. Elsewhere water of variable quality is obtained from wells. The well water contains considerable alkali in some places. Some difficulty has been experienced in getting well water at reasonable depths on higher benches in Eagle Valley.

At least six hot or warm springs are in the area surveyed, and there are many others in the surrounding region. These springs are valued for recreational purposes but have caused a detrimental accumulation of soluble salts in the soils lying below. Most water from these hot springs is very strongly alkaline (pH about 9.5).

The irrigation water is of good quality except on the west and south sides of Baker Valley, where some of the water is strongly alkaline because it is contaminated by soluble salts from hot springs.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent soil materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent soil material, (2) the climate under which the soil-forming material has accumulated and existed since accumulation, (3) the plant and animal life in and on the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of development have acted on the material.

Climate and vegetation change the parent material from an inert heterogeneous mass to a body having more or less definite genetic morphology. Their action on the parent material is hastened or

hindered in varying degree by the relief, which governs to some extent runoff, natural erosion, movement of water through the soil, and the natural vegetation. Throughout the genesis of soil, time brings about changes; hence, age is a factor in soil development. The degree to which the soil develops depends not only on the time but on the rate at which the forces of climate and vegetation act, the effect of these forces, in turn, being regulated by the relief and parent material.

The parent materials of the soils of the Baker area are of three general classes: (1) Bedrock residuum; (2) old fluviatile and lacustrine deposits; and (3) recent or young alluvial and lacustrine deposits. A small quantity of wind-blown material occurs along the western border of Baker Valley. The upper parts of many of the soils probably were influenced in varying degree by loessal or loesslike accumulations.

The residual rocks include large areas of extrusive, or lava, rocks; large areas of highly altered rocks, such as argillite, greenstone, and serpentine; considerable areas of intrusive rocks, such as granites and diorites; and smaller areas of weakly consolidated sedimentary rocks, such as diatomite and conglomerate.

Owing to its varied mineral resources, the area has been of much interest to geologists (*1*, *6*, *8*). The country rock is in general very hard and extremely resistant to weathering. For this reason most soils on bedrock are shallow. The old fluviatile and lacustrine deposits are comparatively young geologically (*1*); but they have given rise to mature or moderately old soils that appear to have received the full influence of their climatic environments. As a general result, soil profiles are strongly developed in areas of smooth relief where natural erosion has not been active. In areas with steep slopes where natural erosion has been more active the soil profiles show only moderate development.

ENVIRONMENT AND CHARACTERISTICS OF SOILS IN THE BAKER AREA

The soils of the Baker area have developed from a variety of parent materials and under a wide range of environmental conditions, and as a result they are extremely varied. The area includes extensive sagebrush-covered hills and several intermountain basins of low relief. The western part extends into the forest on the Blue Mountains, and the northeastern part reaches into the foothills of the forested Wallowa Mountains. The strong and varied relief has a marked influence on the climate, vegetation, and soils.

The climate is of a continental type, but modified by air currents from the Pacific Ocean. The average annual precipitation ranges from 9 inches in the eastern part of the area to more than 45 inches in the mountains. Most of the precipitation falls between November and May. The summers are dry.

Where the average annual precipitation is less than about 13 inches and the natural vegetation is big sagebrush (*Artemisia tridentata*) and grass, light-colored zonal soils of the Brown great soil group[8]

[8] For a discussion of the great soil groups see Soils and Men, U. S. Dept. Agr. Yearbook of Agriculture, 1938 (*10*).

have developed. Where the average annual precipitation ranges from 13 to 22 inches, both limits being approximate, the natural vegetation ranges from grass and sagebrush to grass and scattered trees. Here the zonal soils range from somewhat dark-colored Chestnut soils to dark-colored Prairie soils. Areas receiving more than 20 to 22 inches of precipitation generally are forested with conifers, and the zonal soils are the light-colored Podzolic or Brown Forest soils.

Where the soils are underlain by bedrock and formed under a sagebrush and grass vegetation, the character of the rock has had a striking influence on the accumulation of calcium carbonate in the soil profile. Soils underlain by gabbro, basalt, andesite, phonolite, trondhjemite, biotite-quartz diorite, and limestone have a moderate or strong accumulation of lime in the lower part of the subsoil. Soils developed upon argillite, tuff, diatomite, metagabbro, and serpentine have slight lime accumulation in the lower subsoil. Soils developed upon albite granite and greenstone in most places do not contain sufficient lime in any part of the subsoil to effervesce when dilute hydrochloric acid is applied.

CLASSIFICATION OF SOILS

The soil series of the Baker area are classified by great soil groups and soil orders (zonal, intrazonal, and azonal) in table 6, and the principal soil-forming factors are listed for each series. Some of the soil series are not typical of any great soil group now generally accepted and are therefore listed with the great soil group they most nearly resemble. The classification is therefore tentative, and further study may indicate the need for changes in the classification, and even in the names of some of the great soil groups. The column headed Remarks in table 6 shows which soil series have characteristics of or transitional to other great soil groups or orders and also gives other pertinent information, as, for example, the occurrence of hardpan and alkali. Some of the soils formed under forest vegetation are listed as unclassified. Further study is necessary to classify them properly in great soil groups.

TABLE 6.—*Soil series of the Baker area, Oreg., classified by orders and great soil groups, and the principal factors in their formation*

ZONAL SOILS

Great soil group and series	Natural vegetation	Parent material	Relief	Natural drainage [1]	Precipitation	Remarks
Brown:					*Inches*	
Baker	Sagebrush and grass	Old mixed alluvium, mostly from basalt, argillite, and granite.[2]	Gently sloping to hilly.	Good	9–14	
Barnard	do	Stratified weakly consolidated gravel, clay, tuff, diatomite, and basalt.	do	do	9–12	Contains a calcium carbonate hardpan.
Durkee	do	Argillite residuum	Hilly to steep	do	10–14	
Glasgow	Sagebrush, grass, and in places some bitterbrush and mountain-mahogany.	Volcanic-tuff residuum	Undulating to steep.	do	10–14	Noncalcareous in places; somewhat transitional to Chestnut soils and may include areas of Chestnut soils.
Hutchinson	Grass and sagebrush.	Old alluvium, mostly granitic or dioritic.[2]	Gently sloping to sloping.	do	11–14	Mostly noncalcareous; somewhat transitional to Chestnut soils and may include areas of Chestnut soils.
Lookout	Sagebrush and grass	Basalt or andesite residuum.	Undulating to hilly.	do	9–12	Contains a calcium carbonate hardpan.
North Powder.	do	Biotite-quartz diorite or granite residuum.[2]	do	do	10–14	
Ruckles	do	Basalt, andesite, or gabbro residuum.	Gently sloping to steep.	do	10–13	

Virtue	do	Old mixed alluvium and lacustrine material, mostly from basalt, granite, quartz, argillite, and greenstone.	Nearly level to moderately steep.	do	10–13	Contains a calcium carbonate hardpan.
Chestnut:						
Bulger	Grass and sagebrush.	Old alluvium, mostly from granite and quartz.[2]	Undulating	do	13–15	Vary from a typical Chestnut soil in being noncalcareous in most places and in containing a hardpan; somewhat transitional to Brown soils and may include areas of Brown soils.
Clover Creek	Grass and sagebrush; considerable bitterbrush and mountainmahogany.	Limestone residuum	Gently rolling to hilly.	do	13–15	In places somewhat transitional to Brown soils and may include areas of Brown soils.
Gem	Grass and sagebrush.	Basalt, phonolite, or andesite residuum.	Gently rolling to steep.	do	13–16	
Hibbard	do	Old mixed alluvium, mostly from argillite and quartz.	do	do	13–16	
Keating	do	Greenstone residuum	do	do	11–16	Vary from a typical Chestnut soil in being noncalcareous in most places; somewhat transitional to Brown soils and may include areas of Brown soils.
Salisbury	do	Old mixed gravelly alluvium, mostly from argillite mixed with basalt and granite material.	Undulating to rolling.	do	13–15	Contain a hardpan.

See footnotes at end of table.

TABLE 6.—*Soil series of the Baker area, Oreg., classified by orders and great soil groups, and the principal factors in their formation*—Continued

ZONAL SOILS

Great soil group and series	Natural vegetation	Parent material	Relief	Natural drainage [1]	Precipitation	Remarks
					Inches	
Turnbow	Grass	Serpentine residuum	Rolling to steep	Good	12–16	Vary from a typical Chestnut soil in being noncalcareous in most places.
Prairie:						
Applegate	Grass, some bitterbrush, and a few trees and shrubs.	Old mixed alluvium, mostly from basalt and granite.	Gently sloping to hilly.	do	17–25	
Brownlee	Grass and sagebrush; some bitterbrush and a few pines in places.	Albite granite residuum.	Undulating to steep.	do	15–21	Included are areas resembling Chernozem or Chestnut soils, but these areas are noncalcareous partly because of a deficiency of calcium in parent material. Except for being noncalcareous, included areas most nearly resemble Chestnut soils.
Halfway	Grass and in places a few shrubs and trees.	Old mixed alluvium, mostly from basalt and granite.	Level, nearly level, or slightly depressed.	Imperfect to moderately good.	17–25	Somewhat transitional between Prarie and Humic Gley soils.
Ladd	Grass and sagebrush.	Old alluvium, mostly from granite and diorite.	Gently sloping to hilly.	Good	15–19	

Langrell	Grass, shrubs, and a few trees.	Mixed alluvium, mostly granitic, but some basaltic and greenstone material.	Gently sloping	do	17–25	Transitional to Alluvial soils and may include Alluvial soils; also may include areas resembling Chernozem or Chestnut soils but these areas are noncalcareous partly because of deficiency of calcium in the parent material. Except for being noncalcareous included areas most nearly resemble Chestnut soils.
Mehlhorn	Grass, bitterbrush, sagebrush, and a few aspens, haw, and ponderosa pine.	Basalt residuum	Gently sloping to steep.	do	15–25	
Unclassified:						
Kilmerque	Ponderosa pine forest, in places mixed with other trees.	Biotite-quartz diorite residuum.[2]	do	do	18–30	Transitional between Brown Forest and Brown Podzolic soils.
McEwen	Ponderosa pine forest.	Old mixed alluvium, mostly from granite, basalt, and argillite.	do	do	20–25	Transitional between Gray-Brown Podzolic and Brown Forest soils.
Moscow	do	Albite granite residuum	do	do	20–30	Do.
Rouen	Ponderosa pine mixed in places with larch and fir.	Argillite residuum [2]	do	do	20–35	Do.
Springdale	Open ponderosa pine forest.	Sandy over gravelly mixed alluvium mostly from granite and argillite.[2]	Nearly level to gently sloping.	Somewhat excessive.	12–20	Owing to youth and the coarse parent material, somewhat transitional between Alluvial and Brown Podzolic soils.
Underwood	Ponderosa pine forest in places mixed with larch and fir.	Basalt or other basic igneous residuum.	Rolling to steep	Good	20–30	Resemble Brown Forest soils.

See footnotes at end of table.

TABLE 6.—*Soil series of the Baker area, Oreg., classified by orders and great soil groups, and the principal factors in their formation*—Continued

INTRAZONAL SOILS

Great soil group and series	Natural vegetation	Parent material	Relief	Natural drainage [1]	Precipitation	Remarks
Solonchak:					*Inches*	
Baldock	Grass and some sagebrush, greasewood, or rabbitbrush in places.	Recent to young medium-textured mixed alluvium and lacustrine material, chiefly from basalt, argillite, and granite.	Nearly level or level.	Imperfect or poor.	9–13	Where less saline, somewhat transitional to Alluvial or Humic Gley soils.
Gooch	Grass; much saltgrass in places; some greasewood and rabbitbrush in patches.	Recent or young medium to clayey textured mixed alluvium or lacustrine material, mostly from basalt, argillite, and granite.	do	Poor	10–13	Do.
Haines	Saltgrass and in places some greasewood.	Recent, or young, mixed alluvium and lacustrine material, mostly from basalt, granite, and argillite, including volcanic ash.	Level	do	10–12	Most soils affected by alkali.
Stanfield	Greasewood, saltgrass, and rabbitbrush.	Recent or young medium-textured mixed alluvial and lacustrine material, mostly from basalt, granite, and argillite.	do	do	9–13	Most soils affected by alkali; contain a groundwater hardpan.
Umapine	Saltgrass and some greasewood and rabbitbrush.	do	do	do	9–12	Most soils affected by alkali.

Solonetz:						
Lun	Greasewood, sagebrush, rabbitbrush, and saltgrass.	Somewhat old mixed alluvium and lacustrine material, mostly from basalt, granite, and argillite.	Nearly level	Poor or imperfect.	10–12	Solodized-Solonetz in most places.
Humic Gley:						
Catherine	Grass and few shrubs.	Recent or young medium-textured mixed alluvium or lacustrine material, mainly from basalt, granite, and argillite.	Level or nearly level.	Imperfect or poor.	11–25	Noncalcareous; somewhat transitional to Alluvial soils.
Hershal	Grass; a few deciduous trees along streams.	Recent medium-textured over coarse-textured mixed alluvium, mostly from granite, basalt, and argillite.	do	Poor	17–30	Do.
Wingville	Grass and few shrubs.	Recent or young medium-textured mixed alluvium or lacustrine material, mainly from basalt, granite, and argillite.	do	do	10–14	Calcareous.

See footnotes at end of table.

TABLE 6.—*Soil series of the Baker area, Oreg., classified by orders and great soil groups, and the principal factors in their formation*—Continued

AZONAL SOILS

Great soil group and series	Natural vegetation	Parent material	Relief	Natural drainage [1]	Precipitation	Remarks
Alluvial:					*Inches*	
Balm	Grass; in places sagebrush or greasewood; and a few deciduous trees along streams.	Recent medium-textured over coarse-textured mixed alluvium, mostly from basalt, granite, and greenstone.	Nearly level or level.	Poor	9–12	More or less hydromorphic; may be saline.
Onyx	Grass and sagebrush.	Recent medium-textured mixed alluvium, mostly from basalt, argillite, and granite.	do	Good to moderately good.	10–13	
Powder	do	Medium-textured mixed alluvium, mostly from basalt, argillite, granite, and greenstone.	do	do	10–13	Transitional to Brown soils.

[1] The natural drainage classes include: (1) Excessive, (2) somewhat excessive, (3) good, (4) moderately good, (5) imperfect or somewhat poor, (6) poor, and (7) very poor.

[2] In places the upper part of the soil may be derived from a thin covering of loess.

ZONAL SOILS

A zonal soil is any one of the great groups of soils having well-developed soil characteristics that reflect the influence of the active factors of soil genesis (*10*)—climate and living organisms, chiefly vegetation.

The zonal soils in the Baker area are members of the Brown, Chestnut, and Prairie great soil groups, plus several soil series unclassified as to great soil groups.

BROWN SOILS

The Brown great soil group is made up of soils having a grayish-brown to light brownish-gray or pale-brown nearly neutral noncalcareous platy surface soil and a browner more alkaline finer textured subsoil in which there is a distinct horizon of lime accumulation below depths of 1½ to 2½ feet. The Brown soils formed under (1) a sagebrush and grass vegetation, (2) an annual precipitation of 9 to 13 inches, and (3) an annual temperature of 45 to 49° F. Dry summers and cold somewhat snowy winters were climatic factors influencing soil formation. The soil series belonging to this group are the Baker, Barnard, Durkee, Glasgow, Hutchinson, Lookout, North Powder, Ruckles, and Virtue.

The Baker series is representative of the Brown great soil group. Following is a profile description of Baker silt loam about 2 miles northwest of Baker (NW¼NE¼ sec. 13, T. 9 S., R.39E.):

A_1 0 to 5 inches, grayish-brown (10YR 5/2)[9] weakly root-bound soft easily crumbled silt loam; top inch faintly vesicular; material in next 2 inches has weakly developed very fine platy structure and crushes into weak very fine granules or single grains; layer very dark grayish-brown (10YR 3/2) and very friable when moist. pH, 6.7[10].

A_3 5 to 13 inches, grayish-brown (10YR 5/2) slightly hard silt loam of weakly developed fine and very fine granular structure; layer contains few pebbles and many fine roots and is very dark grayish brown (10YR 3/2) and very friable when moist. pH, 6.8.

B_2 13 to 19 inches, grayish-brown (10YR 4.5/2) prismatic clay; tops but not the sides of the prisms are covered with gray material; prisms (about 1 inch wide and 4 inches high) are tough, difficult to penetrate, and break into dense very hard strongly developed fine nuciform aggregates; material is mostly noncalcareous, contains few pebbles, and is dark grayish brown (10YR 4/2) and firm when moist. pH, 8.3.

B_{2ca} 19 to 23 inches, grayish-brown (10YR 5/2) clay; material contains white streaks and spots of lime, breaks into strongly developed rough dense hard angular fine nuciform aggregates, and is rather difficult to penetrate with a crowbar; layer is dark grayish brown (10YR 4/2) and firm when moist. pH, 8.3.

B_{2ca} 23 to 32 inches, pale-brown to brown (10 YR 6/3 to 5/3) silty clay loam containing many segregated streaks of white lime; material breaks into hard slightly dense moderately developed fine nuciform aggregates, contains a few roots, and is brown to dark brown (10YR 5/3 to 4/3) and firm when moist. pH, 8.2.

C_{1ca} 32 to 37 inches, pale-brown to light yellowish-brown (10YR 6/3 to 6/4) loam containing much segregated white lime; material is hard,

[9] Symbols in parentheses are Munsell color notations.

[10] pH determinations by L. T. Alexander, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

slightly dense, moderately fine nuciform, and rather difficult to penetrate with a crowbar; layer is brown to dark brown (10YR 5/3 to 4/3) and friable when moist. pH, 7.8.

C_{2ca} 37 to 50 inches, light yellowish-brown (10YR 6/4) silty clay loam containing much segregated white lime and few pebbles; material is difficult to penetrate with a crowbar, breaks into rough subangular hard fine nuciform aggregates, and is yellowish brown (10YR 5/4) and friable when moist. pH, 7.6.

C_{3ca} 50 to 75 inches, light yellowish-brown (10YR 6/4) faintly calcareous clay loam; material breaks into hard or slightly hard subangular fine nuciform aggregates and is brown to yellowish brown (10 YR 5/3 to 5/4) and friable when moist. pH, 8.1.

C_{4ca} 75 to 83 inches, light yellowish-brown to light yellowish-gray (2.5Y 6/4 to 6/2) highly calcareous massive loam; material contains many subangular and rounded pebbles and is light olive brown to grayish brown (2.5Y 5/4 to 5/2) and very friable when moist. pH, 8.6.

C_{5ca} 83 to 97 inches, light yellowish-brown to light yellowish-gray (2.5Y 6/4 to 6/2) calcareous slightly hard massive silt loam; material easily penetrated and is light olive brown to grayish brown (2.5Y 5/4 to 5/2) and very friable when moist. pH, 8.5.

Where this profile was taken, the altitude is 3,450 feet, the annual precipitation is about 13 inches, the relief is undulating (about 3-percent slopes), and surface drainage is slow. The natural vegetation is big sagebrush, grass, and some rabbitbrush. A nearby field was in dry-farmed wheat when the samples were taken. The soil is derived from old alluvial-fan material of mixed origin, principally from basalt, argillite, granite, and soils formed thereon. Possibly the surface soil is influenced by loessal or loesslike material. Mechanical analyses of this soil profile are given in table 8, in the section on Physical and Chemical Data and Mechanical Analyses of Soils. This profile shows somewhat stronger textural and structural B development than most Baker soils.

The Durkee, Glasgow, North Powder, and Ruckles soils overlie bedrock but in profile development are somewhat similar to Baker silt loam. The Durkee soils have developed on residuum from argillite bedrock, the Glasgow soils on residuum from volcanic tuff, the North Powder soils on residuum from biotite-quartz diorite bedrock, and the Ruckles soils on residuum principally from basalt bedrock. In certain areas, however, the upper part and possibly some of the other parts of some of these soils may have been influenced somewhat by loessal or loesslike material. The Durkee, Glasgow, North Powder, and Ruckles soils all developed under similar natural vegetation, climatic conditions, and drainage, and all are fairly mature. Probably as a partial result of a deficiency of calcium in the volcanic tuff, the Glasgow soils in places have no or only a very weak horizon of calcium carbonate accumulation.

The Barnard, Lookout, and Virtue soils are placed in the Brown great soil group but have definite caliche or lime-hardpan layers in the lower subsoil. The Barnard soils are derived from stratified weakly consolidated gravel, clay, tuff, or diatomite. The Lookout soils have developed principally on residuum from basalt or andesite bedrock, and the Virtue soils, from old mixed alluvium. In some areas the Lookout and Virtue soils may be somewhat transitional between soils of the Brown and Sierozem great soil groups.

Following is a profile description of Virtue silt loam in the southwest corner of section 11, township 9 south, range 40 east:

A_1 0 to 4 inches, light-brownish-gray (10YR 6/2) noncalcareous soft to slightly hard silt loam which is very dark grayish brown to dark grayish brown (10YR 3/2 to 4/2) and friable when moist and contains few pebbles; faintly vesicular but crumbles easily into weak very fine granules; moisture equivalent, 29.0;[11] pH, 7.7.[12]

A_3 4 to 11 inches, light brownish-gray (10YR 6/2) noncalcareous soft to slightly hard silt loam; material dark grayish brown to very dark grayish brown (10 YR 3/2 to 4/2) and friable when moist; breaks with a faint vertical cleavage; crumbles easily into weak very fine granules; and contains many fine roots; moisture equivalent, 25.1; pH, 7.5.

B_2 11 to 16 inches, pale-brown (10YR 6/3) noncalcareous very hard weakly prismatic clay; material is tough and difficult to penetrate with a crowbar; breaks into pieces 3 or 4 inches across, and then into rough subangular strongly developed fine or medium nuciform aggregates; some gray on the fissure planes; material is dark brown (10YR 4/3) and very firm when moist. Moisture equivalent, 32.9; pH, 8.0.

B_{2ca_1} 16 to 21 inches, pale-brown (10YR 6/3) hard heavy clay loam or clay containing much segregated white lime in a threadlike mycelial pattern; material breaks into irregular pieces, then into subangular fine nuciform aggregates, and is dark brown (10YR 4/3) and slightly compact when moist; moisture equivalent, 42.8; pH, 7.9.

B_{2ca_2} 21 to 28 inches, very pale-brown (10YR 7/3 to 8/3) slightly hard clay loam; material breaks into angular aggregates, then into weak very fine granules, and is light yellowish-brown (10YR 6/4) and slightly compact when moist; contains a trace of segregated white lime in the upper part; pH, 8.4.

B_{2mca_1} 28 to 42 inches, very pale-brown (10 YR 8/3) and white (10YR 9/1) dense rocklike calcareous hardpan, which is very difficult to penetrate with a crowbar and breaks into angular fragments; pH, 9.0.

B_{2mca_2} 42 to 60 inches, pale-yellow (2.5Y 7/4), light-gray (2.5Y 7/2), and white (2.5Y 8/2) weak hardpan consisting of lime-cemented gravelly sandy loam; pH, 8.6.

C_{ca} 60 to 72 inches, pale-yellow (2.5Y 7/4) and light-gray (2.5Y 7/2) hard strongly calcareous single-grained sandy loam; moisture equivalent, 12.5; pH, 8.3.

D_1 72 to 87 inches, rather loose incoherent calcareous single-grained sand and gravel containing considerable white (2.5Y 8/2) finer material; gravel is largely basalt with a trace of granite; pH, 8.7.

D_2 87 to 96 inches, very pale-brown (10YR 7/3) calcareous loose incoherent single-grained loamy sand and some gravel; pH, 8.7.

For the above profile surface drainage is slow to medium and relief is undulating. The altitude is about 3,475 feet, and the average annual precipitation is 12 inches. The soil formed under big sagebrush and grass from old alluvial material of mixed origin, but principally from basalt and to some extent from argillite, granite, and soils formed thereon. Perhaps the surface soil has been influenced to some extent by loess or loesslike material.

The Hutchinson soils have formed under grass and sagebrush and an annual precipitation of 11 to 14 inches. They developed from old granitic or dioritic alluvium that in many places may have a thin covering of loess. The surface soil is grayish brown, or slightly

[11] Moisture equivalent determinations made in the soils laboratory of Oregon State College.

[12] pH determination by E. H. Bailey, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

dark grayish brown, and the subsoil is strongly developed texturally and structurally but has little or no lime accumulation. Probably this zone is lacking because the parent material is low in calcium content. Some areas of these soils have somewhat darker surface soil and appear to be transitional to Chestnut soils.

CHESTNUT SOILS

In localities having somewhat more precipitation (12 to 16 inches), soils have formed that have a darker more granular surface soil as a result of a greater growth of grasses and other plants. The natural vegetation typically is grass (mainly bunchgrasses) and big sagebrush, but the grass is denser and makes up more of the vegetative cover than in the region of Brown soils. The greater vegetative growth has allowed a larger return of organic matter and has produced a darker surface soil.

The Chestnut soils have a surface soil ranging from dark grayish brown to dark gray or grayish brown and from 5 to 13 inches in thickness. The subsoil is slightly to strongly developed texturally and structurally. The surface soil and upper subsoil are neutral or mildly alkaline. A horizon of slight or moderate calcium carbonate accumulation is in the lower subsoil at depths of 2 to 3 feet in typical Chestnut soils, but some soils are included with very weak or no lime accumulation.

The Clover Creek, Salisbury, Gem, and Hibbard series are in the Chestnut great soil group. The Clover Creek soils have formed from residuum weathered from hard limestone that occurs as lenses in larger masses of greenstone. They are somewhat transitional to Brown soils and, as mapped, may include areas of Brown soils.

The Salisbury soils have formed from old mixed gravelly or cobbly alluvium, principally argillitic in origin, but mixed with basaltic and granitic materials. They have an indurated hardpan that is only slightly calcareous.

The Gem soils developed principally from residuum from basalt or andesite bedrock, and the Hibbard soils, from old mixed alluvium that is mostly argillitic and quartzitic.

The Bulger, Keating, and Turnbow series have developed under an environment similar to that of the Chestnut soils, but they differ from the typical Chestnut in having no or practically no zone of lime accumulation in their profile. As they occur in a climatic belt where soils with a horizon of calcium carbonate accumulation is normally expected, the absence of such accumulation probably is partly due to a deficiency of calcium in the parent materials. They might be considered as somewhat intrazonal soils.

The Bulger soils have formed from old alluvium, chiefly granitic and quartzitic, and have a hardpan that is typically noncalcareous. The Keating soils have developed from greenstone residuum. They are somewhat transitional to the Brown soils and, as mapped, may include areas of such soils. The Turnbow soils have developed from serpentine residuum under a natural vegetation of grass and sparse sagebrush.

PRAIRIE SOILS

The Applegate, Brownlee, Halfway, Ladd, Langrell, and Mehlhorn are classified as Prairie soils. They occur in the climatic zone just

below the lower edge of the ponderosa-pine belt, where the natural vegetation is mostly grass mixed with some bitterbrush, mountain-mahogany, and in places scattered ponderosa pine. The Brownlee soils extend from this zone into the grass and sagebrush vegetation, where the zonal soils are normally Chestnut.

The Prairie soils have a granular surface soil ranging from dark grayish-brown to very dark gray or dark gray. The soils are neutral to medium acid and have no free calcium carbonate. The Brownlee soils, as mapped, may include areas in the Chernozem or Chestnut soil zones, and the soils in these included areas are noncalcareous partly because of the deficiency of calcium in the parent material. The included areas otherwise may more nearly resemble Chestnut soils. The Brownlee soils are derived from albite-granite residuum. The Langrell soils are derived from recent mixed alluvium that is mostly granitic but includes some materials from basalt and greenstone. The Langrell soils are somewhat transitional to Alluvial soils and may include areas of such soils. Both the Brownlee and Langrell soils are well drained. The Halfway soils are imperfectly or moderately well drained and have mottlings in the lower part of the subsoil. In places they may be affected by a high water table. The Ladd soils have formed from old alluvium that is mostly granitic and dioritic. The Applegate and Mehlhorn soils are not so dark as the other Prairie soils. They are somewhat transitional to forested soils but do not contain A_0 or A_2 horizons. The Applegate soils are derived from old mixed alluvium, mostly basaltic and granitic; the Mehlhorn, from basalt residuum.

UNCLASSIFIED SOILS

The Kilmerque, McEwen, Moscow, Rouen, Springdale, and Underwood soils are unclassified as to great soil group. They are either transitional or require further study. They have formed under ponderosa-pine or mixed coniferous forest and a precipitation of more than 18 inches, although some areas included with Springdale soils are less humid. Most of these soils typically have a thin A_{00} over a thin layer of more or less acid partly decomposed litter (A_0), which in turn lies over a thin somewhat acid A_1 layer. Although the horizon below the A_1 is lighter colored, an A_2 is rather weak or absent except possibly in the Rouen series.

The Rouen series, derived from argillite residuum, is one of this group. Following is a profile description of Rouen stony loam about 8 miles southwest of Baker (sec. 34, T. 9 S., R. 39 E.):

A_{00} 1 to ½ inch, yellowish-brown loose pine needles and other forest litter, including some twigs and pine cones; moisture equivalent, 112.2;[13] pH, 4.4.[14]

A_0 ½ to 0 inch, dark-gray or very dark-brown partly decayed pine needles; pH, 4.8.

A_{11} 0 to ½ inches, dark grayish-brown (10YR 4/2) soft loam containing considerable partly decomposed pine needles and some rock fragments; material has very fine crumb structure and is very dark brown (10YR 2/2) and friable when moist; pH, 4.9.

[13] See footnote 11, p. 155.
[14] See footnote 12, p. 155.

A_{11} ½ to 2 inches, dark grayish-brown to grayish-brown (10YR 4/2 to 5/2) weakly root-bound soft stony loam containing many angular pebbles and stones; material has very fine crumb structure and is very dark brown (10YR 2/2) and friable when moist and slightly sticky when wet; moisture equivalent, 39.0; pH, 5.5.

A_2A_3 2 to 13 inches, very pale-brown (10YR 7/3) slightly hard stony loam containing many roots and angular pebbles and stones; material breaks into rough small easily crumbled aggregates and is yellowish brown (10YR 5/4) and friable when moist; moisture equivalent, 25.6; pH, 5.1.

B_{11} 13 to 18 inches, very pale-brown (10YR 7/3 to 7/4) stony loam or stony clay loam that contains many angular pebbles and stones, breaks into slightly hard fine nuciform aggregates, and is yellowish brown (10YR 5/4) and friable when moist and sticky when wet; moisture equivalent, 23.0; pH, 5.1.

B_{12} 18 to 24 inches very pale-brown (10YR 7/3 to 7/4) slightly hard fine nuciform stony loam containing some partly decomposed rock fragments and some fine roots; yellowish brown (10YR 5/4) and friable when moist; moisture equivalent, 21.7; pH, 5.5.

B_2 24 to 37 inches, brownish-yellow (10YR 6/6) somewhat variegated very hard dense stony clay; prismatic with a distinct but irregular vertical cleavage; prisms break into fine and medium nuciform aggregates; material contains much disintegrated argillite rock and a few fine roots and is yellowish brown (10YR 5/6) and very firm when moist; moisture equivalent, 31.0; pH, 5.7.

B_3 37 to 49 inches, yellow (10YR 7/6 to 7/8) mixed with light reddish-brown (5YR 6/4) very hard dense fine to medium nuciform stony clay containing many rotten rock fragments; material brownish yellow (10YR 6/6 to 6/8) mixed with yellowish red (5YR 5/6) and very firm when moist; moisture equivalent, 32.9; pH, 6.6.

C 49 to 55 inches, pale-yellow (2.5Y 8/4) hard gritty loam and weathered argillite rock with yellow (10YR 7/6 to 7/8) and very dark-gray (10YR 3/1) streaks; when moist it is firm and yellow (10YR 7/6) and brownish yellow (10YR 6/6 to 6/8) with some streaks of black (10YR 2/1) rock; contains a few roots; pH, 6.3.

The altitude is about 4,700 feet, and the estimated average annual precipitation is 23 inches. The natural vegetation is mostly ponderosa pine, a few white fir, and some mountain-mahogany, juniper, and other shrubs. Possibly the upper horizons are influenced somewhat by loessal or loesslike material. This soil is transitional between Gray-Brown Podzolic and Brown Forest soils and is somewhat planosolic.

The Kilmerque, McEwen, and Moscow soils are somewhat similar in their upper profile. The A_2 horizon is absent or weakly expressed. The Kilmerque soils, derived from biotite-quartz diorite residuum, have rather weakly developed textural profiles and appear to be transitional between Brown Forest and Brown Podzolic soils. The Moscow soils have developed from albite granite residuum and are somewhat transitional between Brown Podzolic and Brown Forest soils. The McEwen formed from old mixed alluvium, mostly granitic, basaltic, and argillitic in origin, and appear to be transitional between Brown Forest and the Gray-Brown Podzolic soils.

The Springdale soils have formed from sandy alluvium over coarse mixed alluvium, mostly granitic and argillitic. Owing to youthfulness and coarse parent material, Springdale soils are somewhat transitional between Brown Podzolic and Alluvial soils.

INTRAZONAL SOILS

Intrazonal soils are any of the great groups of soils with more or less well-developed soil characteristics that reflect the dominating

influence of some local factor of relief, parent material, or age over the normal effect of the climate and vegetation. The intrazonal soils in the Baker area are members of the Solonchak, Solonetz, and Humic Gley great soil groups.

SOLONCHAK SOILS

The Solonchak is an intrazonal group of soils having a high concentration of soluble salts, usually a light color, and no characteristic structural form. The Haines, Stanfield, and Umapine soils are classified as Solonchak soils, although some areas may be slightly solonized. In most places they are alkali affected and have pH of 8.5 or above. They are derived from mixed alluvium or lacustrine materials, mostly of basaltic, granitic, or argillitic origin. The Haines soils, however, have a layer of volcanic ash in the lower subsoil. The Haines soils are characterized by a somewhat compact upper subsoil; the Stanfield, by a ground-water lime hardpan; and the Umapine, by the absence of a well-developed hardpan.

The Baldock and Gooch series are also included in this group, although they are somewhat transitional to Alluvial or Humic Gley soils. Apparently they formed under less saline and alkali conditions than the Haines, Stanfield, and Umapine soils and are darker and higher in organic content. Some areas may now be nonsaline.

SOLONETZ SOILS

The Solonetz is an intrazonal group of soils having a variable surface horizon of friable soil underlain by dark hard soil. The hard soil is ordinarily of columnar structure and usually highly alkaline. The Lun soil is in this group, though in many areas it may be a solodized Solonetz soil.

HUMIC GLEY SOILS

Humic Gley is an intrazonal group of soils with a dark-gray, very dark-gray, or very dark-brown horizon high in organic matter that grades at depths of 6 to 30 inches into gray soil. The Catherine, Hershal, and Wingville soils are classed as Humic Gley. They may be transitional between Humic Gley and Alluvial soils. They apparently have formed from relatively recent mixed alluvium under imperfect or poor drainage and a cover of grass and some shrubs. They have a dark surface soil and a gray or mottled subsoil. The Wingville soils differ from the Catherine and Hershal soils in being calcareous. The Hershal soils are younger, browner, and less dark than the Catherine soils.

AZONAL SOILS

Azonal soils are any group of soils without well-developed profile characteristics because of their youth, parent material, or relief that prevent the development of soil-profile characteristics. The azonal soils in the Baker area are in the Alluvial great soil group.

ALLUVIAL SOILS

The Alluvial soils group is made up of azonal soils developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original ma-

terial by soil-forming processes. The Balm, Onyx, and Powder series are in the Alluvial group. The Balm soils are imperfectly or poorly drained and may be saline in places. All except the Onyx soils are calcareous. In places the Powder soils are slightly transitional to Brown soils.

PHYSICAL AND CHEMICAL DATA AND CHEMICAL ANALYSES OF SOILS

Moisture equivalents and total nitrogen values for certain soils of the Baker area are given in table 7. The moisture equivalent is the amount of moisture, expressed in percentage of oven-dry weight, that a soil will hold against a force 1,000 times that of gravity. Generally, a soil with a moisture equivalent of less than 10 is very sandy and porous and very low in water-holding capacity, whereas one having an equivalent between 10 and 20 is usually a sandy loam or coarse loam of fair water-holding capacity. A soil with a moisture equivalent of 20 to 35 is generally a fine-textured loam, silt loam, or friable clay loam with a good water-holding capacity. A soil with a moisture equivalent exceeding 35 is either fine-textured or high in content of organic matter. A high organic-matter content greatly increases the moisture equivalent of any soil, whatever its texture. For example, the organic layer covering forested soils generally has a moisture equivalent of more than 100.

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*

[Analyses made in laboratories of Oregon State College]

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
Applegate clay loam:	*Inches*	*Percent*	*Percent*
10	0–6	25. 8	0. 1085
11	6–16	24. 2	. 0584
12	16–40	27. 5	. 0396
13	40–48	17. 9	----------
14	48–60	17. 4	----------
Baker silt loam:			
348	0–5	29. 1	. 2010
349	5–13	26. 9	. 1002
350	13–19	45. 6	. 0387
351	19–23	34. 6	. 0291
352	23–32	37. 7	. 0140
353	32–37	25. 4	. 0080
354	37–50	30. 7	. 0237
355	50–75	28. 1	----------
356	75–83	23. 9	----------
357	83–97	28. 7	----------
Baldock loam:			
274	0–5	27. 2	. 0953
275	5–13	26. 3	. 0716
276	13–18	22. 7	. 1031
277	18–26	21. 1	. 0629
278	26–34	21. 1	. 0547
279	34–40	17. 6	. 0291
280	40–56	16. 9	. 0266
281	56–67	15. 8	. 0329
282	67–74	16. 9	. 0179

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
	Inches	*Percent*	*Percent*
Baldock silt loam:			
292	0–4	41. 6	. 2294
293	4–7	39. 5	. 1699
294	7–11	36. 3	. 1394
295	11–13	35. 0	. 1021
296	13–21	30. 4	. 0832
297	21–29	31. 2	. 0620
298	29–37	31. 8	. 0436
299	37–62	30. 4	. 0344
300	62–73	26. 2	. 0513
301	73–81	5. 3	----------
302	81–89	15. 7	----------
Balm gravelly sandy loam:			
174	0–5	15. 0	. 1205
175	5–15	14. 8	. 1128
176	15–17	11. 8	. 0784
177	17–44	4. 4	. 0266
178	44–60	3. 7	. 0257
Balm loam:			
498	0–6	20. 5	. 1076
499	6–22	19. 0	. 0780
500	22–60	5. 4	. 0592
Barnard clay loam:			
546	0–8	28. 8	. 1106
547	8–14	35. 3	. 1082
548	14–19	40. 9	. 0653
549	19–23	41. 5	. 0740
550	23–28	37. 6	. 0407
551	28–36	29. 7	----------
552	36–51	30. 4	----------
553	51–57	31. 5	----------
554	57–67	36. 0	----------
555	67–72	17. 2	----------
Brownlee loam:			
717	0–3	20. 4	. 2020
718	3–15	18. 9	. 1630
719	15–18	18. 8	. 1409
720	18–21	17. 4	. 1310
721	21–34	17. 1	. 0824
722	34–54	16. 0	----------
723	54–64	19. 4	----------
724	64–75	24. 3	----------
Brownlee loam, shallow phase:			
629	0–3½	20. 8	. 1608
630	3½–6	20. 8	. 1446
631	6–8	24. 2	. 1034
632	8–14	23. 7	. 1011
633	14–18	23. 3	. 0683
634	18–26	18. 5	. 0301
635	26–38	16. 9	. 0222
636	38–49	14. 7	----------
637	49–60	15. 7	----------
Bulger silt loam:			
383	0–6	28. 5	. 2953
384	6–13	23. 4	. 0792
385	13–18	17. 2	. 0396
386	18–25	18. 2	. 0245
387	25–37	21. 9	. 0188

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
Bulger silt loam—Continued	*Inches*	*Percent*	*Percent*
388	37–44	18. 3	----------
389	44–50	15. 7	. 0334
390	50–74	13. 6	----------
391	74–86	16. 3	----------
Catherine loam:			
136	0–5	41. 4	. 4738
137	5–13	41. 0	. 3325
138	13–21	41. 2	. 1898
139	21–26	31. 7	. 0784
140	26–45	33. 0	. 0484
141	45–52	36. 1	. 0348
142	52–75	34. 4	. 0281
143	75–79	19. 6	. 0324
Catherine silt loam:			
532	0–6	35. 9	. 4174
533	6–11	30. 6	. 2513
534	11–16	23. 1	. 1433
535	16–25	33. 2	. 1847
536	25–49	33. 4	----------
537	49–74	24. 4	----------
538	47–80	20. 6	----------
Catherine silty clay loam, overwash phase:			
235	0–9	37. 5	. 2033
236	9–14	36. 5	. 2221
237	14–18	34. 3	. 2110
238	18–27	33. 0	. 0823
239	27–32	28. 5	. 0711
240	32–35	18. 6	. 0552
241	35–39	19. 3	. 0740
242	39–60	4. 8	. 0329
Clover Creek stony loam:			
615	0–4	27. 5	. 2207
616	4–9	26. 1	. 1404
617	9–14	28. 0	. 0994
618	14–28	32. 2	. 0675
619	28–34	35. 8	. 0530
Durkee stony clay loam:			
652	0–4	26. 6	. 1643
653	4–10	27. 5	. 1446
654	10–14	26. 0	. 1438
655	14–19	29. 5	. 1632
656	19–24	33. 3	. 0978
657	24–32	29. 7	. 0944
658	32–42	17. 3	. 0894
Gem clay:			
592	0–2½	44. 8	. 1344
593	2½–11	46. 1	. 0718
594	11–19	52. 1	. 0787
595	19–23	60. 5	. 1003
596	23–29	49. 8	. 0891
597	29–32	45. 1	. 1040
598	32–35	34. 9	. 0810
599	35–47	----------	. 0506
600	47–59	22. 7	----------
601	59–68	20. 9	----------

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
	Inches	*Percent*	*Percent*
Glasgow silt loam:			
700	0–5	32. 8	. 2914
701	5–10	30. 5	. 1727
702	10–17	29. 7	. 1668
703	17–23	26. 1	. 1005
704	23–26	26. 3	. 0504
Glasgow stony loam:			
644	0–4½	34. 1	. 2816
645	4½–8	30. 6	. 1934
646	8–13	30. 2	. 1381
647	13–15	29. 3	. 0881
648	15–20	38. 2	. 0641
649	20–22	40. 4	. 0431
650	22–32	29. 2	. 0328
651	32–40	29. 6	. 0588
Gooch silt loam:			
283	0–5	37. 4	. 1955
284	5–9	35. 7	. 1646
285	9–15	33. 0	. 1471
286	15–19	32. 2	. 1254
287	19–27	27. 5	. 0532
288	27–41	32. 1	. 0397
289	41–60	34. 5	. 0354
290	60–70	24. 8	. 0198
291	70–81	10. 0	. 0169
Gooch silty clay loam:			
212	0–6	41. 9	. 2870
213	6–18	38. 8	. 1500
214	18–24	34. 6	. 2178
215	24–35	35. 3	. 0552
216	35–48	28. 4	. 0406
217	48–60	28. 3	. 0247
218	60–66	18. 0	. 0290
219	66–72	27. 3	. 0242
220	72–79	19. 4	. 0252
Gooch silty clay loam, alkali-phase:			
100	0–4	35. 1	. 1292
101	4–16	38. 9	. 1186
102	16–25	37. 6	. 0552
103	25–35	38. 9	. 0513
104	35–42	32. 2	. 0213
105	42–50	48. 5	. 0247
106	50–76	6. 7	. 0160
107	76–92	29. 5	. 0581
108	92–106	9. 3	. 0218
Haines silt loam:			
109	0–4	----	----------
110	4–13	32. 5	. 0827
111	13–20	35. 0	. 0605
112	20–24	27. 2	. 0242
113	24–41	32. 8	. 0494
114	41–60	29. 1	. 0315
Halfway clay:			
1	0–3	38. 9	. 3705
2	3–12	34. 0	. 1451
3	12–22	32. 7	. 0390
4	22–25½	36. 1	. 0166
5	25½–33	61. 8	. 0037
6	33–40	41. 9	. 0134

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
Halfway clay—Continued	*Inches*	*Percent*	*Percent*
7	40–44	26. 7	----------
8	44–54	30. 2	----------
9	54–60	17. 8	----------
Halfway clay loam:			
79	0–9	27. 4	. 2260
80	9–19	31. 1	. 1369
81	19–28	26. 1	. 0811
82	28–42	34. 0	. 0489
83	42–60	31. 3	----------
84	60–96	33. 5	----------
85	96–108	35. 3	----------
Halfway silt loam:			
50	0–7	33. 4	----------
51	7–12	29. 7	. 2046
52	12–24	33. 7	. 1432
53	24–31	34. 2	. 1275
54	31–46	31. 9	----------
55	46–56	32. 5	----------
56	56–78	16. 6	----------
57	78–90	8. 5	----------
Hershal silt loam:			
58	0–9	31. 8	. 2327
59	9–21	29. 5	. 1822
60	21–30	41. 9	. 1726
61	30–39	18. 1	. 0421
62	39–54	4. 7	----------
Hershal silt loam, gravelly subsoil phase:			
187	0–6	41. 7	. 3819
188	6–26	34. 4	. 1510
189	26–31	28. 0	. 0528
190	31–45	18. 2	. 0581
191	45–51	12. 9	. 0344
192	51–62	8. 3	. 0257
Hibbard clay:			
251	0–5	29. 3	. 2468
252	5–11	31. 5	. 1985
253	11–19	34. 2	. 0832
254	19–34	38. 5	. 0610
255	34–37	35. 3	. 0504
256	37–45	35. 3	. 0456
257	45–70	32. 2	. 0378
258	70–84	35. 3	. 0183
Hibbard clay loam:			
358	0–5	26. 3	. 1267
359	5–13	25. 6	. 1013
360	13–20	23. 1	. 0637
361	20–23	22. 1	. 0588
362	23–44	23. 7	. 0357
363	44–57	28. 6	. 0498
364	57–80	14. 8	. 0484
Hibbard silt loam:			
243	0–5	27. 2	. 1539
244	5–11	28. 9	. 1713
245	11–14	24. 0	. 0886
246	14–17	22. 1	. 0576
247	17–29	22. 9	. 0450
248	29–49	19. 3	. 0160
249	49–62	15. 4	. 0194
250	62–84	21. 7	. 0130

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
	Inches	*Percent*	*Percent*
Hibbard stony clay:			
585	0–6	30. 4	. 1544
586	6–12	36. 1	. 0869
587	12–17	36. 8	. 0972
588	17–19	44. 4	. 1362
589	19–35	44. 3	. 0867
590	35–50	35. 5	----------
591	50–72	34. 6	----------
Hutchinson loam:			
162	0–6	31. 3	. 2115
163	6–19	32. 1	. 1085
164	19–22	21. 2	. 0542
165	22–28	38. 1	. 0571
166	28–37	20. 5	. 0314
167	37–54	22. 9	. 0169
168	54–66	31. 1	. 0189
Hutchinson loam, shallow phase:			
144	0–6	26. 1	. 2289
145	6–14	21. 5	. 1186
146	14–32	17. 8	. 0469
147	32–37	13. 9	. 0271
148	37–50	12. 2	. 0164
149	50–60	12. 6	. 0189
150	60–72	11. 2	. 0164
Keating loam:			
602	0–6	19. 6	. 1169
603	6–10	19. 7	. 1184
604	10–15	20. 6	. 0989
605	15–20	19. 6	. 0660
606	20–26	20. 7	. 0530
607	26–35	20. 0	. 0278
608	35–48	11. 9	----------
609	48–51	12. 6	----------
Keating loam, deep phase:			
669	0–4	30. 2	. 2942
670	4–16	30. 3	. 1941
671	16–33	28. 9	. 1677
672	33–46	26. 9	----------
673	46–54	27. 8	----------
674	54–65	28. 3	----------
675	65–100	26. 4	----------
Keating stony loam:			
611	0–4	18. 6	. 1192
612	6–8	18. 8	. 0792
613	10–18	19. 7	. 0864
Kilmerque loam:			
21	0–1	44. 4	. 3400
22	1–3	32. 0	. 1201
23	3–9	22. 6	. 0378
24	9–20	21. 0	. 0393
25	20–37	16. 3	. 0166
26	37–46	13. 4	----------
27	46–70	14. 0	----------
Kilmerque sandy loam:			
375	2–1	----------	. 8479
376	1–0	----------	. 6896
377	0–1	20. 5	. 1155
378	1–9	19. 6	. 0957
379	9–17	14. 7	. 0137

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
Kilmerque sandy loam—Continued	*Inches*	*Percent*	*Percent*
380	17–36	9.0	.0219
381	36–65	8.4	.0027
382	65–76	4.7	.0222
Ladd loam:			
125	0–5	19.0	.1418
126	5–7	19.8	.1084
127	7–17	30.6	.0537
128	17–22	29.7	.0402
129	22–31	26.9	.0387
130	31–42	20.5	.0320
131	42–51	17.6	.0291
132	51–84	5.8	.0150
133	84–91	6.9	.0155
134	91–96	11.3	.0256
135	96–102	10.8	.0160
Ladd loam, alluvial fan phase:			
28	0–10	26.7	.1286
29	10–23	25.3	.0770
30	23–33	23.1	.0588
31	33–70	20.8	----------
32A	70–91	----------	----------
Ladd loam, deep phase:			
732	0–6	31.4	.2292
733	6–10	31.3	.2267
734	10–13	29.3	.1908
735	13–18	26.1	.1209
736	18–24	25.1	.1003
737	24–32	24.0	.0574
738	32–38	24.6	.0512
739	38–49	28.2	----------
740	49–60	27.4	----------
741	60–66	21.0	----------
Langrell gravelly loam:			
32	0–3	24.0	.2466
33	3–6	15.5	.0742
34	6–9	18.6	.0777
35	9–12	19.1	.0733
36	12–21	19.0	.0564
37	21–30	18.9	.0439
38	30–60	12.1	.0069
Langrell loam:			
15	0–8	28.8	.2512
16	8–29	25.2	.1288
17	29–38	23.7	.0410
18	38–56	11.1	----------
Lookout clay loam:			
563	0–4	31.5	.1597
564	4–11	32.7	.0931
565	11–18	40.8	.0839
566	18–22	38.2	.0710
567	22–30	35.0	.0395
568	30–42	32.1	.0347
569	42–64	34.6	----------
570	64–72	29.3	----------
Lookout stony clay loam:			
556	0–3	25.5	.1228
557	3–7	29.9	.1338
558	7–14	35.8	.1828

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
Lookout stony clay loam—Continued	*Inches*	*Percent*	*Percent*
559	14–17	46. 9	. 0993
560	17–21	44. 7	. 1446
561	21–23	51. 9	. 1021
Lun silt loam:			
92	0–2½	26. 7	. 0822
93	2½–6	25. 6	. 0661
94	6–18	41. 1	. 0326
95	18–32	38. 1	. 0060
96	32–43	24. 6	----------
97	43–54	25. 6	----------
98	54–60	18. 5	----------
99	60–72	9. 1	----------
McEwen loam:			
179	0–2½	26. 5	. 1452
180	2½–8	26. 4	. 0944
181	8–13	24. 1	. 0595
182	13–18	19. 8	. 0431
183	18–35	19. 2	. 0387
184	35–53	17. 7	. 0295
185	53–64	13. 2	. 0334
186	64–70	12. 9	. 0208
McEwen loam, overwash phase:			
221	0–6	23. 4	. 1849
222	6–10	31. 9	. 0808
223	10–16	22. 8	. 0953
224	16–23	16. 1	. 0595
225	23–28	17. 3	. 0586
226	28–36	15. 4	. 0532
227	36–46	10. 4	. 0344
228	46–60	10. 5	. 0247
Mehlhorn clay loam:			
45	0–6	30. 7	. 1634
46	6–13	29. 1	. 1007
47	13–22	28. 1	. 0754
48	22–38	29. 8	. 0330
49	38–64	30. 8	----------
Mehlhorn stony clay loam:			
67	0–4½	24. 4	. 0607
68	4½–11	30. 6	. 0566
69	11–36	38. 5	. 0067
Moscow loam:			
706	2–1	----------	1. 2917
707	1–0	----------	. 7901
708	0–1	38. 6	. 4532
709	1–4	17. 1	. 2260
710	4–8	15. 1	. 1137
711	8–11	13. 7	. 0902
712	11–15	11. 6	. 0605
713	15–19	11. 3	. 0402
714	19–22	8. 3	. 0179
715	22–51	7. 2	. 0242
716	51–59	6. 1	----------
Muck:			
63	0–9	----------	. 0070
64	9–18	54. 1	. 4927
65	18–54	28. 7	. 0681
66	54–62	19. 2	----------

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
North Powder loam:	*Inches*	*Percent*	*Percent*
725	0–5	27. 2	. 2118
726	5–10	26. 0	. 1203
727	10–17	24. 2	. 1100
728	17–19	16. 7	. 0941
729	19–25	13. 9	. 0778
730	25–32	9. 8	. 0092
731	32–50	7. 9	----------
Onyx silt loam:			
445	0–6	22. 5	. 1036
446	6–10	21. 0	. 0962
447	10–15	19. 8	. 0672
448	15–24	12. 3	. 0326
449	24–29	17. 8	. 0262
450	29–35	22. 7	. 0422
451	35–48	20. 3	----------
452	48–54	19. 0	----------
453	54–60	20. 6	----------
454	60–80	22. 0	----------
455	80–98	24. 8	----------
Onyx silt loam, alluvial-fan phase:			
392	0–7	27. 4	. 1540
393	7–16	27. 9	. 1050
394	16–24	19. 5	. 0536
395	24–30	18. 9	. 0387
396	30–36	19. 3	. 0222
397	36–58	16. 9	----------
398	58–70	11. 0	----------
Powder silt loam:			
473	0–4	25. 0	. 2314
474	4–10	24. 0	. 1461
475	10–23	22. 6	. 0662
476	23–31	28. 0	. 0777
477	31–51	28. 2	----------
478	51–95	27. 2	----------
Rouen stony loam:			
749	1–½	112. 2	1. 1045
750	½–0	----------	. 3557
751	0–½	----------	. 5033
752	½–2	39. 0	. 3292
753	2–13	25. 6	. 0683
754	13–18	23. 0	. 0445
755	18–24	21. 7	. 0300
756	24–38	31. 0	----------
757	38–49	32. 9	----------
758	49–55	32. 3	----------
Ruckles loam:			
321	0–3	22. 5	. 0299
322	3–7	22. 5	. 0372
323	7–10	24. 9	. 0221
324	10–17	31. 1	. 0291
325	17–23	23. 7	. 0079
326	23–30	16. 6	. 0040
327	30–37	22. 2	. 0289
328	37–43	39. 5	----------
329	43–55	39. 8	----------
330	55–61	33. 9	----------

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
	Inches	*Percent*	*Percent*
Salisbury gravelly loam:			
229	0–5	28. 4	. 1404
230	5–9	28. 9	. 0987
231	9–11½	38. 2	. 0687
232	11½–20	32. 5	. 0412
233	20–59	19. 7	. 0159
234	59–63	21. 3	. 0194
Springdale fine sandy loam:			
303	0–7	25. 8	. 0823
304	7–14	23. 2	. 0757
305	14–19	15. 8	. 0302
306	19–30	13. 7	. 0196
307	30–36	7. 6	. 0276
308	36–48	6. 2	----------
309	48–60	7. 2	----------
Springdale gravelly sandy loam:			
399	0–4	26. 6	. 1520
400	4–10	23. 1	. 0763
401	10–14	21. 1	. 0447
402	14–31	13. 1	. 0262
403	31–54	5. 7	----------
Springdale stony sandy loam:			
365	0–6	30. 1	. 2306
366	6–17	25. 8	. 1621
367	17–60	21. 1	. 0535
Springdale very fine sandy loam:			
259	0– 5	31. 0	. 1921
260	5–16	29. 5	. 1626
261	16–25	26. 4	. 1316
262	25–28	17. 4	. 0837
263	28–32	17. 8	. 0759
264	32–37	16. 0	. 0620
265	37–60	10. 0	. 0503
Stanfield silt loam:			
193	0–2	25. 0	. 1292
194	2–4	24. 5	. 0779
195	4–11	33. 8	. 0823
196	11–16	41. 4	. 0615
197	16–27	41. 4	. 0508
198	27–34	45. 0	. 0227
199	34–41	43. 5	. 0286
200	41–47	47. 9	. 0247
201	47–70	39. 2	. 0256
202	70–108	30. 6	. 0261
203	108–178	14. 7	. 0198
Turnbow stony clay:			
639	0–3	34. 1	. 1856
640	3–5	35. 3	. 1782
641	5–14	44. 6	. 1733
642	14–23	44. 4	. 1666
Umapine silt loam:			
341	0–3	25. 8	. 1991
342	3–5	19. 7	. 0885
343	5–11	18. 7	. 0628
344	11–18	21. 4	. 0218
345	18–53	14. 3	. 0042
346	53–84	15. 8	. 0266
347	84–91	17. 6	----------

TABLE 7.—*Moisture equivalents and total nitrogen for certain soils of the Baker area, Oreg.*—Continued

Soil name and sample No.	Depth	Moisture equivalent	Total nitrogen
Underwood loam:	*Inches*	*Percent*	*Percent*
71	¾–0	----------	1. 0820
72	0–1	34. 9	. 2495
73	1–3	32. 6	. 2107
74	3–12	29. 9	. 1339
75	12–21	30. 2	. 0561
76	21–34	32. 1	. 0330
77	34–41	28. 9	----------
78	41–52	26. 4	----------
Underwood stony loam:			
742	1½–¾	104. 7	1. 1522
743	¾–0	----------	1. 4545
744	0–¾	33. 6	. 2228
745	¾–4	26. 4	. 0958
746	4–6½	26. 2	. 1007
747	6½–22	20. 7	. 0232
748	22–39	15. 4	. 0059
Virtue silt loam:			
115	0–4	29. 0	. 2006
116	4–11	25. 1	. 0885
117	11–16	32. 9	. 0687
118	16–21	42. 8	. 0798
119	21–28	35. 8	. 0644
120	28–42	----------	. 0600
121	42–60	----------	. 0247
122	60–72	12. 5	. 0184
123	72–87	15. 8	. 0208
124	87–96	26. 2	. 0232
Virtue cobbly loam:			
676	0–4	32. 0	. 1791
677	4–11	30. 2	. 1686
678	11–17	31. 2	. 0769
679	17–21	48. 0	. 0616
680	21–28	78. 1	. 0607
681	28–32	45. 9	. 0605
682	32–44	43. 7	----------
683	44–56	35. 7	----------
684	56–72	31. 2	----------
Wingville silty clay loam:			
430	0–5	40. 3	. 2688
431	5–30	38. 1	. 0946
432	30–45	37. 2	----------
433	45–57	23. 0	. 0203
434	57–67	10. 5	----------

Mechanical analyses and organic content of three soils of the Baker area are presented in table 8.

TABLE 8.—*Mechanical analyses and organic content of three soils in the Baker area, Oreg.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	Organic matter
Baker silt loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
5622348	0–5	0.5	1.2	1.4	7.0	11.6	59.2	19.1	2.6
5622349	5–13	1.2	1.5	1.7	8.1	10.5	59.2	17.8	1.5
5622350	13–19	1.0	2.2	1.9	3.0	7.4	36.6	47.9	0.2
5622351	19–23	1.8	3.0	2.3	6.4	6.7	37.4	42.4	0.0
5622352	23–32	.9	2.2	1.8	5.9	7.3	42.9	39.0	0.0
5622353	32–37	5.2	9.1	7.5	19.4	11.2	25.1	22.5	0.1
5622354	37–50	2.1	2.2	1.8	6.3	5.6	46.9	35.1	0.0
5622355	50–75	6.6	5.3	3.6	10.1	8.8	34.2	31.4	0.0
5622356	75–83	6.9	7.3	5.3	14.9	12.7	33.0	19.9	0.1
5622357	83–97	2.1	3.8	2.9	8.3	10.8	62.6	9.5	0.2
Brownlee loam:									
5622717	0–3	9.9	13.4	7.1	10.6	7.4	34.4	17.2	3.5
5622718	3–15	5.8	12.1	7.7	11.9	9.6	35.2	17.7	1.9
5622719	15–18	5.1	9.9	6.8	12.3	10.7	37.7	17.5	1.8
5622720	18–21	4.7	10.6	7.5	12.7	10.2	35.2	19.1	1.4
5622721	21–34	4.0	9.9	7.5	13.0	10.2	33.2	22.2	0.7
5622722	34–54	9.1	14.8	8.2	12.7	8.5	28.4	18.3	0.1
5622723	54–64	4.9	13.9	9.5	16.1	11.0	32.0	12.6	0.0
5622724	64–75	3.0	12.4	8.4	14.7	11.9	38.8	10.8	0.0
Glasgow silt loam:									
5622700	0–5	1.0	3.9	3.0	7.6	10.8	62.4	11.3	3.3
5622701	5–10	4.1	4.0	3.0	9.7	11.8	48.8	18.6	2.3
5622702	10–17	1.5	3.5	2.7	7.0	9.2	57.0	19.1	2.2
5622703	17–23	1.6	3.7	2.9	5.6	8.1	53.8	24.3	0.0
5622704	23–26	1.7	5.2	3.7	6.4	7.2	50.3	25.5	1.4
5622705	26–40	17.3	17.0	7.4	10.6	6.2	23.2	18.3	0.4

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