tains rise abruptly from broad valleys, and receive upon the summits a considerable amount of rain and snow. The streams have cut deep canyons, and as they issue upon the plains their waters are diverted by many canals and ditches. Nearly all of these have been built by associations of farmers living in small communities on the bench land near the mouths of the canyons. There are very few large structures built by capital obtained outside the state, and, so far as can be ascertained, all investments of this character have been financially unsuccessful. On the other hand, the farmers, uniting in associations and furnishing their own labor and teams, have built works, some of them of considerable magnitude, and through the use of these have increased the value of their property to such an extent as to make the investment highly remunerative. It is to be noted, however, that it is the owner and tiller of the soil who has become prosperous, and not the owner of the irrigating system. One of the largest works in the state is the Bear River Canal, a portion of which is shown on Pl. LV.

Growing out of the complete church organization of the people have come methods of allotting and distributing water which have proved sufficient for most localities. Controversies occasionally arise, but these are usually settled by what amounts to a majority vote of those concerned. There is an attempt made to divide water by priority of

time at which it was put to beneficial use, but the strict regard to priorities has often been set aside in favor of a more equitable distribution during times of scarcity. In other words, priorities have been disregarded in favor of needs of men owning orchards which would be destroyed if water could not be had, temporarily at least. There is also put in practice a grouping of rights as described on p. 293.

The Bear, Ogden, and Weber rivers are the principal streams of the western part of the state, and receive a considerable part of the drainage of the Wasatch Mountains. The most notable river, however, is the Jordan, which flows into Great Salt Lake from the south, being the outlet of Utah Lake. The latter body of water lies at an elevation considerably above Great Salt Lake, so much so that its waters are taken out by canals covering the valley lands and extending to the city of Salt Lake.

Utah Lake receives from the east a number of large streams, the most important of which is Provo River. The ordinary flow of this and other streams is fully utilized during the summer, and extension of irrigation is dependent upon water storage, for which there are a number of favorable sites in the mountains. One of the most important developments for the state is the complete regulation of these head-water streams by the construction of impounding dams and the control of Utah

Lake, by which its waters may he drained down to a small extent and the lake made available to the greatest possible capacity for lands in Salt Lake Valley.

At about the centre of the state is Sevier River, which flows from the high plateaus and mountains of the southern part of the state northerly toward Utah Lake, but, before reaching it, turns abruptly to the west, its waters finally disappearing in a marsh or sink, known as Sevier Lake. A number of important towns and farming communities are located in the valleys along this river, and the water is as fully used as can be without storage. Excellent opportunities exist for conserving water, and on some of the tributary streams small reservoirs have already been built by the farmers.

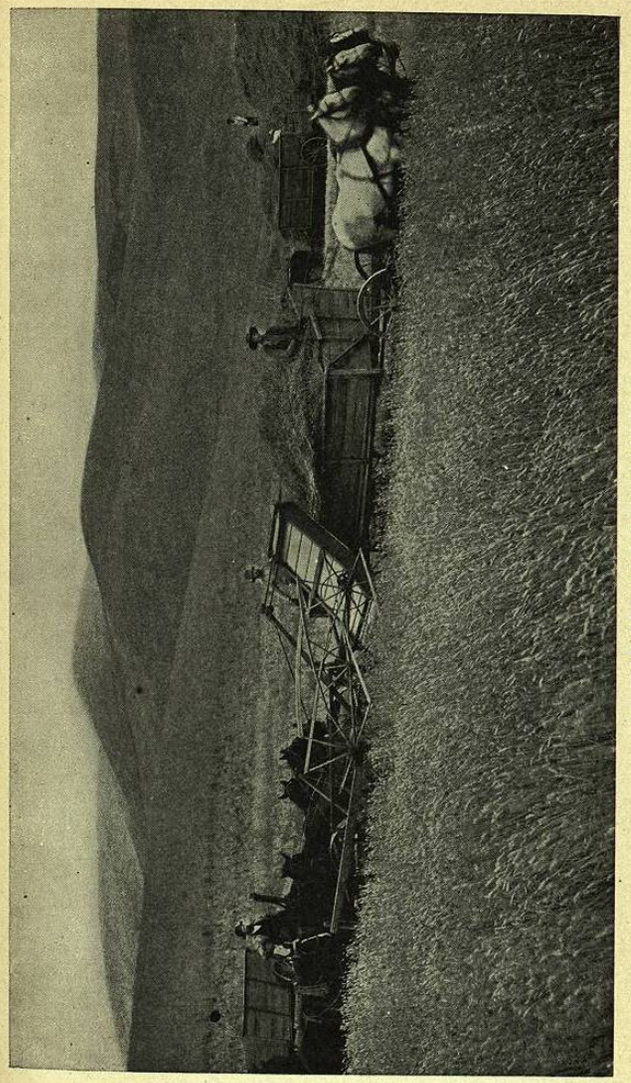
The eastern side of the state is drained by Colorado River and its tributaries, the largest of which is the Green. Near the head waters these streams are used to a small extent on the lands of the elevated plateaus and of the small valleys intersecting them, but the general character of this drainage is typified by the Colorado, which flows in a deep, narrow canyon without any bottom land. The greater part of the water is thus lost to agriculture, although it may be of industrial value in the future as a source of power. If any of it is to be used for irrigation, this can be accomplished only by storage and diversion near the head waters, before the streams have cut down into the solid rocks.

This river escapes to the Pacific Ocean through the Gulf of California, but, with the exception of this drainage area, the state of Utah lies wholly within the Great Basin.

The western side of Utah consists of broad, arid valleys interrupted by sharp mountain ranges, and has the desert aspect which characterizes the Great Basin. There is some timber upon the mountains, and also grazing, but the valleys are, for the most part, barren, supporting only a growth of sage brush and similar plants. The difficulty of obtaining water, even for cattle, has prevented the settlement of this country, although prospectors and miners have made temporary homes and camps, some of them important. Artesian waters are found in many parts of the state, especially in the vicinity of Utah Lake and Great Salt Lake. It is possible that deep wells can be successfully sunk in some of the desert valleys.

WASHINGTON.

The western portion of the state of Washington, especially in the region of Puget Sound, is noted for its fogs and heavy rainfall. East of the Cascade Range, however, as in Oregon, the country is extremely dry, except near the Canadian border and among the foothills adjacent to northern Idaho. Throughout eastern Washington, on the rolling uplands, and southerly across Columbia River and around the flank of the Blue Mountains,



WHEAT FIELDS OF WASHINGTON.

is a country which, though possessing a distinctly arid climate, has been found to be one of the best-known areas for raising wheat. The soil, resulting from the decay of basalts and lavas, is extremely rich, and, although almost ashy in texture, has the peculiar property of retaining and transmitting to the plants a sufficient amount of water to insure luxuriant growth. Broad wheat fields, shown on Pl. LVI, extend in every direction as far as the eye can reach, covering a land which has been considered worthless except for grazing. The water supply is very scanty, barely sufficient for domestic purposes. The rivers, like the Columbia and its principal tributaries, flow in deep, narrow canyons, and although the volume of water is large, it is impracticable to bring any of it to the tops of the adjoining cliffs upon which the farms are located.

In the valleys immediately east of the Cascade Mountains irrigation is practised, especially along Yakima River, which receives the waters of the melting snows on high mountains. It flows through a number of valleys in succession, and many small ditches divert water, also a few large canals, the most important of which is known as the Sunnyside Canal (Pl. LVII, *A*), irrigating land below Yakima. The principal crop produced, besides alfalfa and fruits, is hops, the climate being found peculiarly favorable for these.

Columbia River, which flows through the state from Canada, and Snake River, its principal tribu-

tary, are in deep, narrow canyons through the greater part of their courses. Along their banks are many wheels designed to lift water by means of buckets placed upon the rim, as shown on Pl. XLI. These make possible the cultivation of small fruit farms on the narrow strip of land between the river and the foot of the cliffs. These little farms, being sheltered from the wind, and receiving sunshine and warmth, produce fruit of high quality, such as peaches, pears, prunes, and other varieties of plums. These are transported, mainly by water, to the local markets at Portland and elsewhere.

The interior of Washington is in many respects similar to that of Oregon, particularly in what is known as the Great Bend country. Here the streams are small, not having a mountainous catchment area; but it is believed that water conservation is practicable on some of the coulées, as well as on the Palouse River, which flows from the highlands in the eastern part of the state, and on the Pataha, Wallawalla, and similar rivers coming from the Blue Mountains, making possible the reclamation of extensive areas of vacant land. Artesian wells have been sunk in some of the valleys, particularly near Pullman, on the eastern side of the state, and in the Moxee Valley, east of Yakima River. Water-bearing gravels have been found beneath or interbedded with the lava flows. An ideal section of these artesian conditions is given in Fig. 93, prepared by Professor Israel C. Russell.

The mountains in the background are intended to represent the far side of a lava-floored valley. Sands and gravels derived from the mountains have been washed into the valley, and from time to time flows of lava have taken place. A well

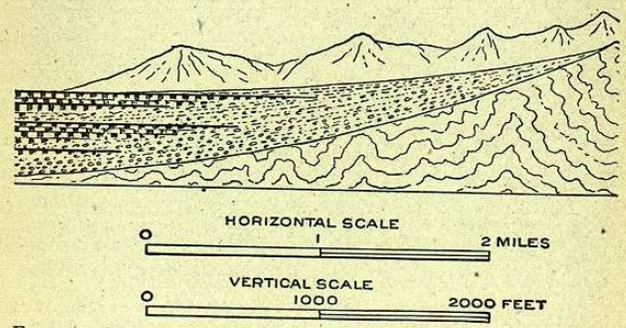


FIG. 94. — Ideal section of the border of the Columbia River lava adjacent to the mountains.

drilled through these lava sheets, until a porous water-charged bed is reached, will yield a surface flow, provided the mouth of the well is below the exposed portion of the pervious layer, and also provided that there is an unbroken impervious bed both above and below it, as described on page 248.

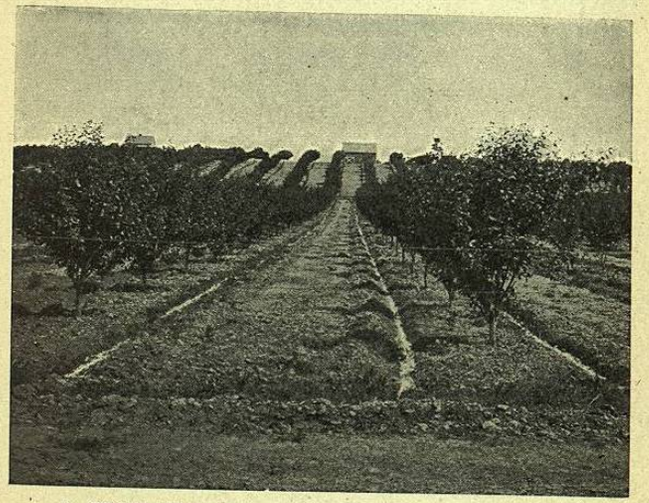
WYOMING.

This state, because of its high altitude, cool climate, and broad, almost desert plains, is and probably always will be devoted mainly to the grazing industry. Mining is of considerable importance, but agriculture is relatively undeveloped.

The altitude of Cheyenne, the capital city, is a little over 6000 feet. This is located on the edge of the high plains, near the foot of the Laramie Hills. From here the plains continue northward between the Black Hills on the eastern edge of the state and the Bighorn Mountains near the centre of the northern part. There is a gradual decline in altitude toward the north, the town of Sheridan having an altitude of about 3700 feet. Here agriculture by irrigation has been most largely developed. In the Bighorn basin, west of the mountains, the altitude is also relatively low, 5000 feet or less, and the water supply large, so that opportunity for the increase of farms is good.

The area of the land surface of the state is 97,575 square miles, or 62,448,000 acres. The population in 1900 was only 92,531, being a little less than one per square mile. The average size of the irrigated holdings is large, since most of these consist of hay farms operated in connection with cattle ranches. The cost of water is correspondingly small, as developments have consisted mainly of ditches for bringing water out upon meadows. The water supply of the state, for an arid region, is not only relatively large, but is well distributed, the principal rivers being the North Platte and its tributary, Sweetwater River, receiving the drainage of the southeastern part of the state, Powder River, on the east side of the Bighorn Mountains, and the Bighorn, on the west side

A. SUNNYSIDE CANAL, WASHINGTON.



B. FRUIT ORCHARD, YAKIMA VALLEY, WASHINGTON.

of the same range, also Green River in the southwest corner. Some of these are of such size that there is little probability that the waters will ever be seriously diminished by irrigation; but on the east side of the Bighorn Range, in the vicinity of Buffalo and Sheridan, there is already demand for water storage.

One of the most important irrigation systems of the state is that in the vicinity of Wheatland, north of Cheyenne. Water is obtained by a tunnel through the Laramie Range, being brought from Laramie River to the east front of these mountains, where it is distributed by a number of canals. The ordinary flow of the river is increased by a storage reservoir built above the mouth of the tunnel, and the available supply is further regulated by storage works in the vicinity of the irrigated land.