Geohydrologic Evaluation of Streamflow Records in the Big Wood River Basin, Idaho

By REX O. SMITH

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1479

An assessment of the geohydrologic conditions that affect the adequacy of streamflow records in measuring the water yield of a basin

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1960

UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

The U.S. Geological Survey Library has cataloged this publication as follows:

Smith, Rex Onis, 1924–

Geohydrologic evaluation of streamflow records in the Big Wood River basin, Idaho. Washington, U.S. Govt. Print. Off., 1959.

v, 70 p. illus., maps (2 fold. in pocket) diagrs., tables. 24 cm. (U.S. Geological Survey. Water-supply paper 1479)

An assessment of the geohydrologic conditions that affect the adequacy of streamflow records in measuring the water yield of a basin.

Bibliography: p. 58–59.

1. Water, Underground—Idaho—Big Wood River basin. 2. Water-supply—Idaho—Big Wood River basin. I. Title. (Series)

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

CONTENTS

ILLUSTRATIONS

[Plates in pocket]

TABLES

GEOHYDROLOGIC EVALUATION OF STREAMFLOW RECORDS IN THE BIG WOOD RIVER BASIN, IDAHO

By Rex O. Smith

ABSTRACT

The Big Wood River basin covers an area of about 3,300 square miles in south-central Idaho. A preliminary study was made both of the geologic and ground-water conditions in the vicinity of stream-gaging stations on the Big Wood River and its tributaries and of the effects of those conditions on streamflow. The accuracy or validity of streamflow records was not questioned, but information was sought on the relation of measured streamflow and water yield (total outflow through either surface channels or subsurface aquifers) of the basin above the gaging stations where the records were collected.

Streamflow records give essentially the water yield of a drainage basin above the gaging station if there is little or no ground-water underflow from the basin. However, stations situated where geologic conditions allow considerable water to pass ungaged, by underflow beneath or around the gage, will not record the water yield.

The extent of further agricultural or commercial development and the stability of existing development in areas where much water is used or needed may depend upon adequate appraisal of the water yield of a basin or a part of a basin.

The water yield of the Big Wood River basin is not estimated in this report, but the geohydrologic conditions that affect the adequacy of existing records in measuring the water yield are assessed.

The formations exposed in the basin range in age from Precambrian to Recent, and include a wide variety of rock types. These may be grouped broadly as pre-Tertiary sedimentary rocks, pre-Tertiary granitic rocks, Tertiary intrusive rocks, Tertiary volcanic rocks, basalt of Quaternary age, unconsolidated Quaternary sediments, and Quaternary windblown materials.

The pre-Tertiary sedimentary and granitic rocks and the Tertiary intrusive rocks are not important aquifers, although locally they yield small amounts of water. The Tertiary volcanic rocks yield small to moderate amounts of water to springs. Basalt of Quaternary age is the principal aquifer in the southern third of the basin. Unconsolidated Quaternary sediments, consisting of coarse sand and gravel with tongues and lenses of silt and clay, are the principal aquifers in the valleys and lowlands of the northern mountainous half of the basin.

The geohydrologic conditions at some gaging stations in the Big Wood River basin are relatively simple, requiring little explanation or interpretation. A station on Warm Springs Creek at Guyer Hot Springs near Ketchum, and another on the West Fork of Fish Creek near Carey, for example, provide records that seem to accurately represent the water yield of the drainage area above the stations. At those stations subsurface movement of ground water

through the alluvial valley fill is a negligible part of the water yield, and the relatively impermeable bedrock beneath the alluvium transmits little or no ground water.

The records from other stations do not represent the water yield of the basin. Notable examples are stations in the alluvium-filled upper valley of the Big Wood River, and along the northern edge of the Snake River basalt, where an appreciable part of the water yield is ground-water underflow. Ungaged ground-water underflow through alluvium in the Big Wood River valley probably is a significantly large part of the water yield of the basin above the stations on the Big Wood River near Ketchum and at Hailey. Much of the water yield of the Silver Creek drainage area and possibly an appreciable part of the water yield of the Camas Creek drainage area enter the basalt of the Snake River Plain upstream from gaging stations and leave those subbasins as ungaged underflow. The amount of ungaged ground-water underflow that passes through alluvium and basalt in the Little Wood River valley and which eventually enters the basalt of the Snake River Plain is unknown, but it may be a large part of the water yield of the Little Wood River drainage area. Much of the water yield of the Fish Creek drainage area enters basalt and alluvium upstream from the Fish Creek gaging station and bypasses the station.

Elsewhere in the Big Wood River basin, especially in extensively irrigated areas on the Snake River Plain, complex geologic and hydrologic factors such as ground-water underflow through permeable basalt, importation of Snake River water for irrigation, ground-water recharge derived from imported water, return of ground water at shallow depths to surface streams, and exchange of water between canals, limit the usability of station records in appraising water yield. An analysis of the ratio of ground-water to surface-water discharge, and the relation of each to the water yield in these areas is not possible from available data. Nevertheless, these stations retain their basic value of recording streamflow at the stations and seepage losses between stations. The large volume of ground water that moves beneath these stations includes recharge contributions from the Big Wood River basin and other basins to the east.

The water yield of specific basin segments could be computed if adequate ground-water data were available from strategically located gaging stations. A more detailed study of water resources in the Big Wood River basin seems to be warranted.

INTRODUCTION

PURPOSE AND SCOPE OF REPORT

The Big Wood River basin is an important agricultural area in southern Idaho. Existing agriculture depends largely on storage, diversion, and utilization of surface water for irrigation. In recent years, however, ground water has been tapped to furnish water for irrigating additional land and it will probably be the source of water used in future development of irrigation. Thus, the water yield of the Big Wood River basin is of direct concern and important to all water users in the basin. Water yield is defined by Langbein (1949) as the total outflow from a drainage basin through either surface channels or subsurface aquifers.

Stream-discharge measurements afford records of the amount of water flowing on the surface past a given point. At most gaging stations in the Big Wood River basin the amount of water discharged at the surface is not the water yield of the drainage basin above the station, because some water either passes beneath or around the station as ungaged underflow or leaves the basin as underflow upstream from the gage. The amount of underflow may range from a small amount to a very substantial part of the water yield. For that reason determination or estimation of the amount of ungaged water that leaves the basin would be very useful for further development and utilization of water supplies.

The data herein supplement a previously published evaluation of the effect of surface-water diversions on streamflow records of the Big Wood River basin (Jones, 1952). The purpose of the present investigation was to ascertain the nature and significance of geologic factors that affect the occurrence and movement of ground water, the rate of discharge in surface streams, and the applicability of records of discharge at gaging stations. Study of the geologic factors is one step in evaluating the gage records as measures of the water yield of the basin above the stations. The purpose, then, is not to estimate water yield, but to describe and evaluate the geohydrologic factors that should be considered by those who may make such an estimate.

Recognition and use of geohydrologic data are essential to full interpretation and evaluation of streamflow records, whether to form estimates of water yield or to explain or adjust apparent variations and anomalies in the records themselves. Geohydrologic information now available for the Big Wood River basin is not a sufficient basis for accurate evaluation of streamflow records from all stations, chiefly because geologic and ground-water data for the vicinity of most gages are not adequate to permit computation of the amount of ground water discharged by underflow from various parts of the basin. Nevertheless, the data do assist quantitative estimation of the relative proportions of gaged surface flow and ungaged underflow at some locations. At most other locations qualitative estimates can be made.

Geologic and ground-water data are pertinent considerations in the selection of gaging-station sites and in the evaluation and interpretation of station records. This report, in addition to assisting evaluation of records from the Big Wood River basin, seeks to enumerate and cite illustrations of certain types of geohydrologic factors that affect the suitability of station sites.

The sections of the report entitled "Geography," "Water-bearing properties of geologic formations," and "Geohydrology of subdivisions of the Big Wood River basin" provide the background for the subsequent section, "Geohydrologic appraisal of gaging-station records." The first three sections emphasize the outstanding geographic and geohydrologic features of the Big Wood River basin, such as the distinctly different types of terrane within the basin, the diverse character of the rocks and their capacities to store and transmit water, the infiltration capacities of rocks and sediments, and the locations of surface and subsurface drainage divides.

Field investigation by the writer, between September 15 and November 7, 1952, consisted chiefly of a reconnaissance of the general regional geology and hydrology of the basin, and more careful study in small local areas, with special emphasis on geologic and ground-water conditions in the vicinity of each stream-gaging station. In critical and key areas a few representative water wells were canvassed, their water levels were measured, pumpage information was collected (table 2), and well logs were compiled. Mosaics of aerial photographs of the area were used as a field base for reconnaissance mapping of areas for which existing maps were unsatisfactory.

The investigation was under the immediate supervision of R. L. Nace, district geologist, Boise, Idaho. J. W. Stewart and R. W. Mower assisted in canvassing wells and collecting drillers' logs. E. G. Crosthwaite reviewed the fieldwork and contributed many helpful suggestions during the writing of the report.

LOCATION AND EXTENT OF AREA

The area here described includes the entire Big Wood River basin, from its headwaters and upper main stem in the mountains of central Idaho to the lower main stem and mouth on the Snake River Plain. This basin, including the tributary areas drained by Camas Creek, Silver Creek, Fish Creek, and the Little Wood River, occupies about 3,300 square miles in south-central Idaho (index map, fig. 1), and includes large parts of Blaine, Camas, Gooding, and Lincoln Counties and a small area in northeastern Elmore County.

Hailey, the seat of Blaine County, is in the upper part of the valley of the Big Wood River. Fairfield, the seat of Camas County, is centrally situated in the Camas Creek basin (Camas Prairie). Shoshone and Gooding, the seats of Lincoln and Gooding Counties, respectively, are in the central part of the southern plains section of the basin. The area is served by branch lines of the Union Pacific Railroad, by U.S. Highways 20, 26, 93, and 93A, by State Highways 23, 24, 25, 46, and 68, and by many county roads.

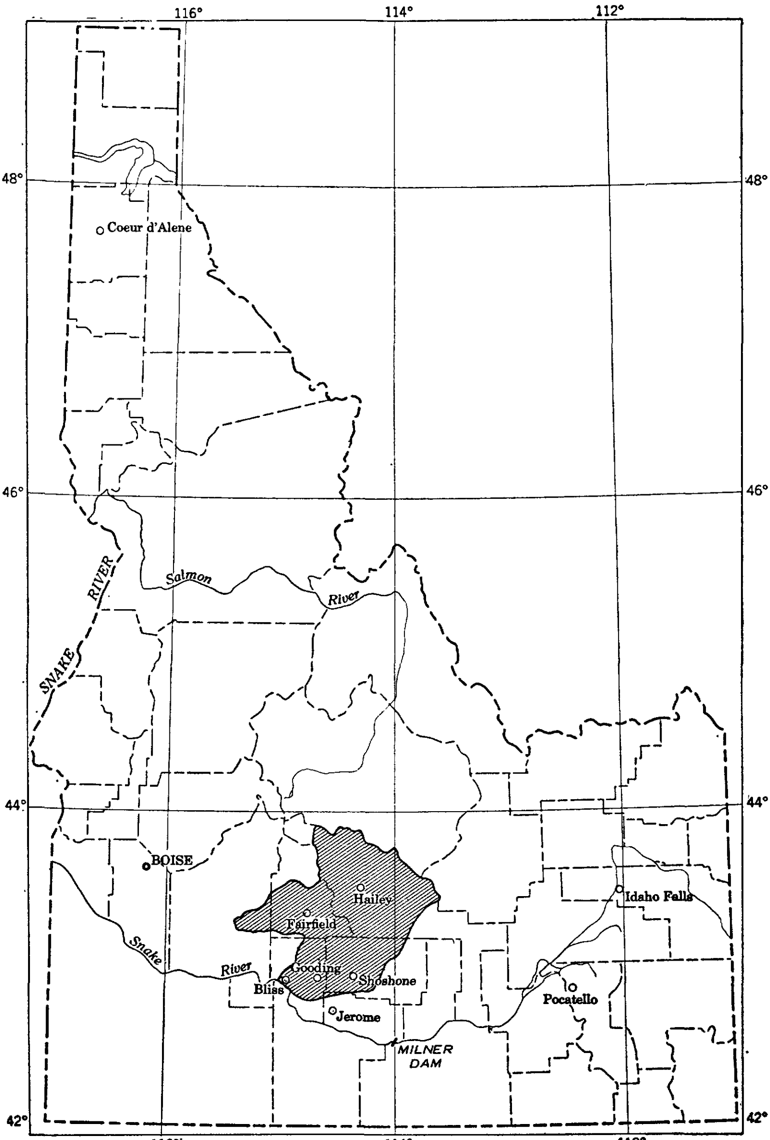

FIGURE 1.—Index map of Idaho showing area covered by this report.

WELL- AND SPRING-NUMBERING SYSTEM

The well-numbering system used in Idaho by the U.S. Geological Survey indicates the locations of wells within official rectangular subdivisions of the public lands, with reference to the Boise base line and meridian. The first number and letter designate the township, and the second designate the range. The third number is the section, and the two letters and the numeral that follow are the quarter section, the 40-acre tract, and the serial number of the well within the tract, respectively. Quarter sections are lettered *a*, *b*, *c*, and *d* in counterclockwise order, from the northeast quarter of each section (fig. 2). Within the quarter sections 40-acre tracts are lettered in the same manner. The serial numbers of the wells indicate the order in which the wells were first visited within the 40-acre tracts. For example, well 1S–18E–12ba1 is the well first visited in the NE¼NW¼ sec. 12, T. 1 S., R. 18 E. Springs are numbered in the same manner as wells, but a capital *S* is inserted between the last two letters and the last numeral: 4N–18E–22cbS1.

PREVIOUS INVESTIGATIONS

A report by Stearns and others (1938) on the geology and water resources of the Snake River Plain included data on the Big Wood

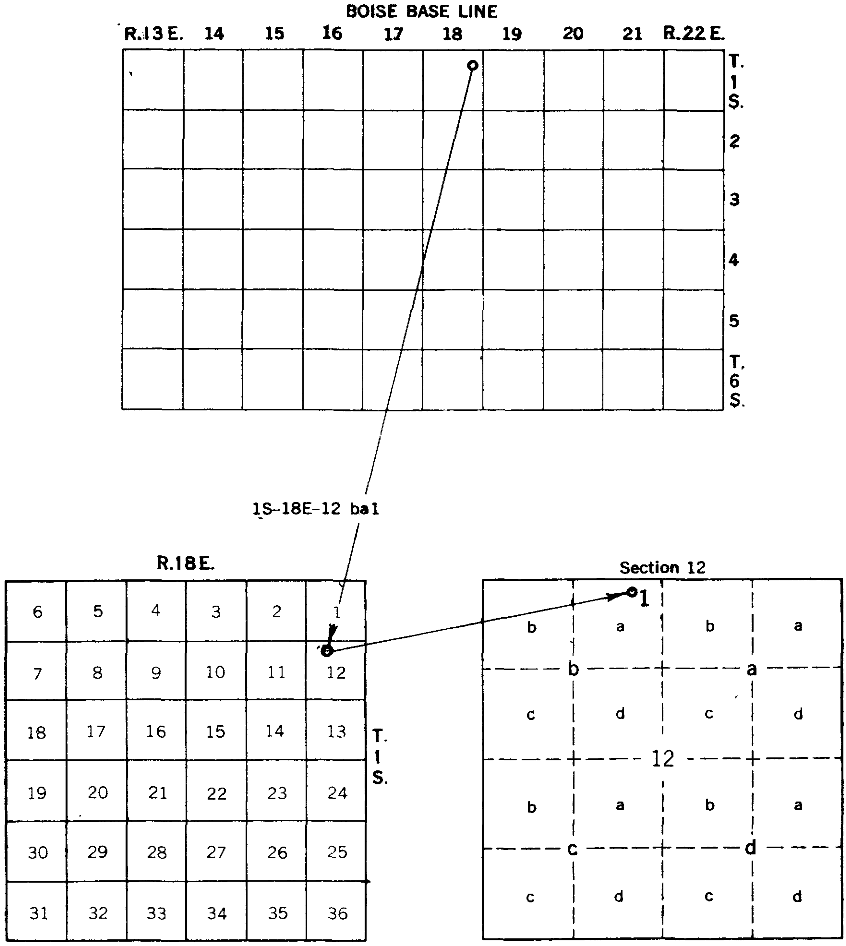

FIGURE 2.—Diagram illustrating well- and spring-numbering system.

River basin. Piper (1924) reported on the geology and ground-water resources of Camas Prairie. Chapman (1921) briefly described ground-water conditions in the upper Big Wood River valley. Several reports have been published on the geology and ore deposits of local districts in the area. These include reports by Umpleby, Westgate, and Ross (1930) on the Wood River region and by Anderson and Wagner (1946) on the Muldoon mining district of the Little Wood River basin. A detailed study of the geology and mineralization of the Hailey-Bellevue mining district was made by Anderson, Kiilsgaard, and Fryklund (1950). An evaluation of the effect of surface-water diversions on streamflow records for the Big Wood River basin was prepared by Jones (1952).

ACKNOWLEDGMENTS

Mans H. Coffin, watermaster for the Big and Little Wood River districts, made available copies of his unpublished annual reports on irrigation districts 7–AB and 11–AB, and furnished much other useful information. Woodrow Watts, deputy watermaster for the Upper Big Wood River, supplied information about the location of many wells. James Wheeler, of Gannett, contributed information about wells and local ground-water conditions. E. W. Walker, George Roessler, J. Emmett Smith, George G. Perkins, and H. H. Francis, well drillers, furnished very useful information and copies of logs for wells in the area. Many residents cooperated by giving information about their wells and permitting access for measurements. T. R. Newell, W. I. Travis, and T. O. Miller, engineers of the U.S. Geological Survey Surface Water Branch, were especially helpful in making discharge measurements used in determining underflow, and in reviewing the report. G. E. Smith and James Pate, of the U.S. Department of Agriculture, gave access to aerial photographs of the area. The assistance of all these individuals is gratefully acknowledged.

GEOGRAPHY

TOPOGRAPHY AND DRAINAGE

The headwaters area of the Big Wood River basin, containing about one-third of the basin, is a rugged region having strong relief (see pl. 1). The valleys of the Big Wood River and its tributaries narrow and deepen upstream, becoming gorges in the headward reaches. The mountain slopes rise steeply from the narrow valley floors and form narrow interstream divides. The heads of some tributary valleys open into well-developed cirques. The principal geographic features are labeled on plate 2.

The mountain summits along most of the basin divide northeast of Ketchum, on the drainage divide and boundary between Custer and Blaine Counties, are 3,000 to 4,000 feet above the principal stream valleys and at some places attain altitudes of more than 10,000 feet above mean sea level. From the vicinity of Ketchum southward to Bellevue some peaks attain altitudes of 8,000 feet or more and the relief between mountains and valleys ranges from 2,000 to 2,500 feet. The only flat tracts are the narrow valley floors and discontinuous river terraces in the valleys of the Big Wood and Little Wood Rivers and some of their principal tributaries. Three miles south of Bellevue the valley of the Big Wood River widens abruptly and from there southward it has a broad, nearly flat floor formed by unconsolidated sediments. The alluvial floor is bounded on the west by mountains of moderate relief, on the northeast by a steep mountain slope, and on the south by the Picabo Hills.

The Picabo Hills, which have moderately high relief, extend from Magic Reservoir eastward to the town of Picabo. The hills have a steep northern face and a more gentle southern slope. Near Magic Reservoir the crest is lower in altitude and more rounded in form.

Camas Prairie is in the west-central section of the Big Wood River basin and is bounded on the north and west by the Soldier Mountains and on the south by the Mount Bennett Hills. The nearly flat alluvial plain of the prairie is about 28 miles long from east to west, and about 8 miles wide at the widest point. The gently sloping surface of the prairie drops from an altitude of about 5,100 feet on the west and along the northern mountain front, to about 5,000 feet at the foot of the Mount Bennett Hills on the southeast. The prairie terminates on the southeast against the gently rolling surface of the Snake River Plain. On the east Camas Prairie ends against an older high alluvial plain which has been dissected by streams into a series of low, rounded hills. The steep north escarpment of the Mount Bennett Hills bounds the prairie on the south, where the hills separate it from the Snake River Plain. The flat-topped crest of the hills reaches an altitude of 6,800 feet in places and is only slightly dissected by erosion.

The lower third of the Big Wood River basin, south of the Mount Bennett and Picabo Hills, is part of the Snake River Plain. The surface of the plain is but little modified by erosion except where the Big and Little Wood Rivers and several tributary streams have cut deep, narrow gorges. Elsewhere, the plain is gently rolling and has low relief except where there are scattered volcanic cones and rough surfaces of fresh basalt flows such as the Shoshone lava field. The plain slopes southwestward from an altitude of 4,670 feet at Tikura to 3,260 feet at Bliss.

The principal streams in the Big Wood River basin are the Big Wood and Little Wood Rivers and Camas Creek. The Big Wood River, the master stream of the basin, rises to the north in high mountain ranges and flows south-southeast for about 40 miles to the vicinity of Bellevue. The principal tributaries to the Big Wood River above Magic Reservoir are the North and East Forks, and Warm Springs, Trail, Deer, and Croy Creeks. Below Bellevue the river leaves its mountain valley and flows along the west margin of a broad alluvial plain, whence it flows to Magic Reservoir through a short, narrow valley.

Camas Creek and its tributaries rise in High Prairie and the Soldier Mountains; the creek then follows the southern edge of Camas Prairie to Magic Reservoir. The drainage pattern is asymmetrical, with most tributaries entering the master stream from the north side. The principal north-side tributaries are Willow Creek, Soldier Creek, Three Mile Creek, and several smaller streams. Lake Creek is the only important tributary entering from the south.

Below Magic Reservoir the Big Wood River flows southward for 20 miles across the Snake River Plain to a point several miles northeast of Shoshone. There the river turns rather sharply and continues westward and southwestward for about 35 miles to the Snake River. The only important tributaries along the lower reach of the river are the Little Wood River, Thorn Creek, and Dry Creek. The last two rise in the Mount Bennett Hills and flow southward.

The Little Wood River rises along the drainage divide between Custer and Blaine Counties and flows southward to the vicinity of Carey, whence it flows southwestward to Shoshone. From Shoshone the Little Wood River flows westward to its confluence with the Big Wood, 4½ miles west of Gooding. The principal tributary to the upper reach of the river is Muldoon Creek. Silver Creek, a spring-fed stream, drains the southeastern part of the alluvial plain in the middle valley of the Big Wood River and enters the Little Wood River near Tikura. The mountainous area east of the Little Wood River is drained by Fish Creek. Prior to the construction of Fish Creek Reservoir the entire flow of Fish Creek sank into the Snake River basalt a short distance from the mountain front. At present a diversion canal transmits the water from Fish Creek to irrigated land in the Little Wood River basin.

CLIMATE AND VEGETATION

The extreme range in relief and topographic forms in different parts of the Big Wood River basin causes wide variations in climate. The principal climatic characteristics of the region—precipitation, temperature, dates of killing frosts, and length of growing seasons at five U.S. Weather Bureau stations, are summarized in table 1 and are shown graphically in figures 3 to 7.

The mountainous northern part of the basin has long cold winters and short relatively cool summers. Winter snowfall is heavy at the higher altitudes and snow sometimes remains on the high ridges during June. The strong local relief causes some differences in temperature and precipitation between the lower and higher altitudes. In the comparatively low sheltered country near and south of Hailey the winter weather is relatively mild and the valleys usually are free of snow by May, though the foothills may contain drifts.

Precipitation in the Camas Creek basin is about the same as that in the vicinity of Hailey. At Hill City, in the western part of Camas Prairie, the normal annual precipitation (U.S. Weather

TABLE 1.—*Temperature, length of growing season, and date of killing frosts in the Big Wood River basin*

[From publications of the U.S. Weather Bureau]

Location of station	Temperature (°F)			Average length of growing season (days)	Date of killing frosts			
					Last in spring		First in autumn	
	Mean annual	Highest recorded	Lowest recorded		Average	Latest recorded	Average	Earliest recorded
Soldier Creek Ranger Station.	37.5	100	−34	80	June 21	July 30	Sept. 9	Aug. 11
Hill City	40.3	102	−44	78	June 14	July 19	Aug. 31	Aug. 2
Hailey	43.5	109	−36	110	May 30	June 30	Sept. 17	Aug. 9
Shoshone	47.0	106	−36	113	May 26	June 29	Sept. 16	Aug. 28
Gooding	47.6	110	−34	124	May 21	June 15	Sept. 22	Sept. 14

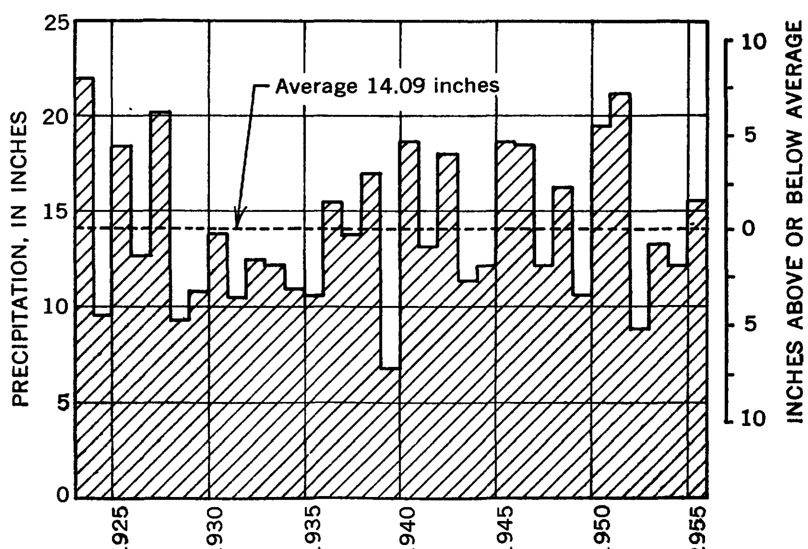

FIGURE 3.—Annual precipitation at Hill City.

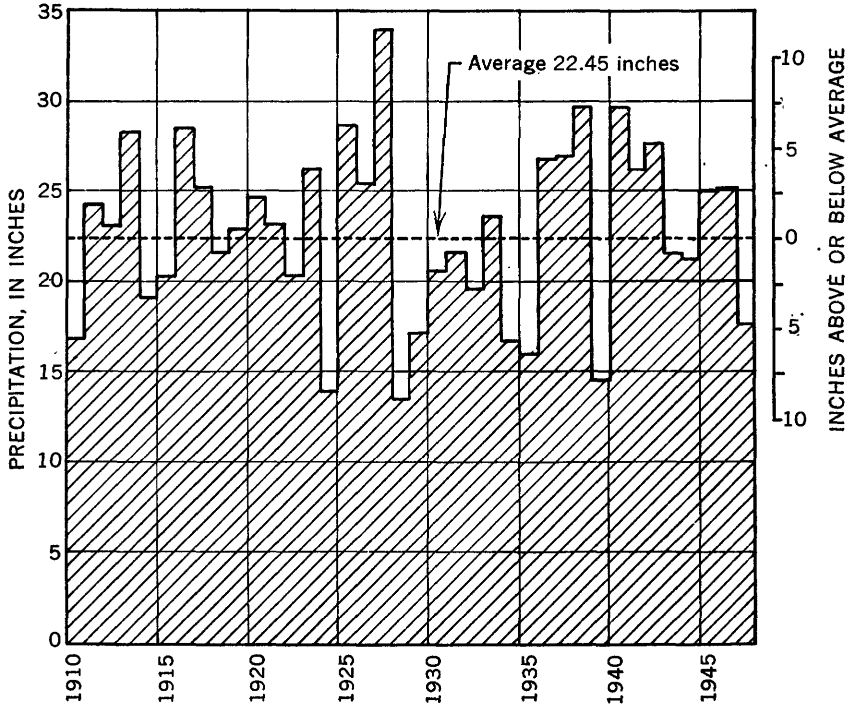

FIGURE 4.—Annual precipitation at Soldier Creek Ranger Station.

Bureau "normal") during 32 years of record was 14.09 inches, compared to a normal of 15.33 inches at Hailey during a 46-year period. The average growing season of 78 days in Camas Prairie is about a month shorter than that in the Hailey area, and the mean annual temperature is several degrees lower than at Hailey.

The climate of the southern third of the Big Wood River basin is semiarid, like that of much of the Snake River Plain, with hot summers and cold winters. The mean annual temperature on the

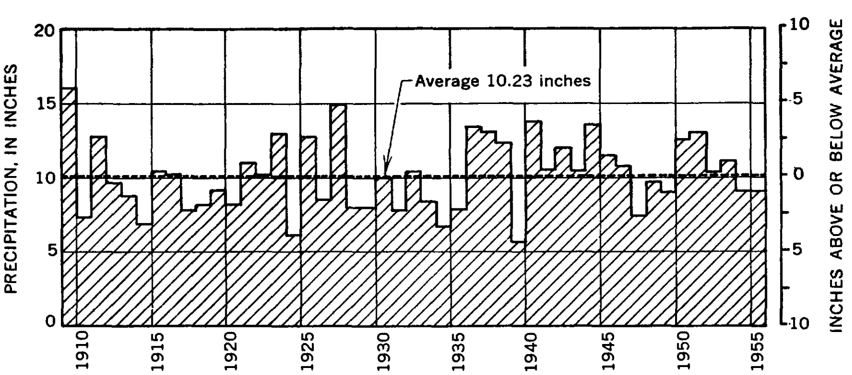

FIGURE 5.—Annual precipitation at Shoshone.

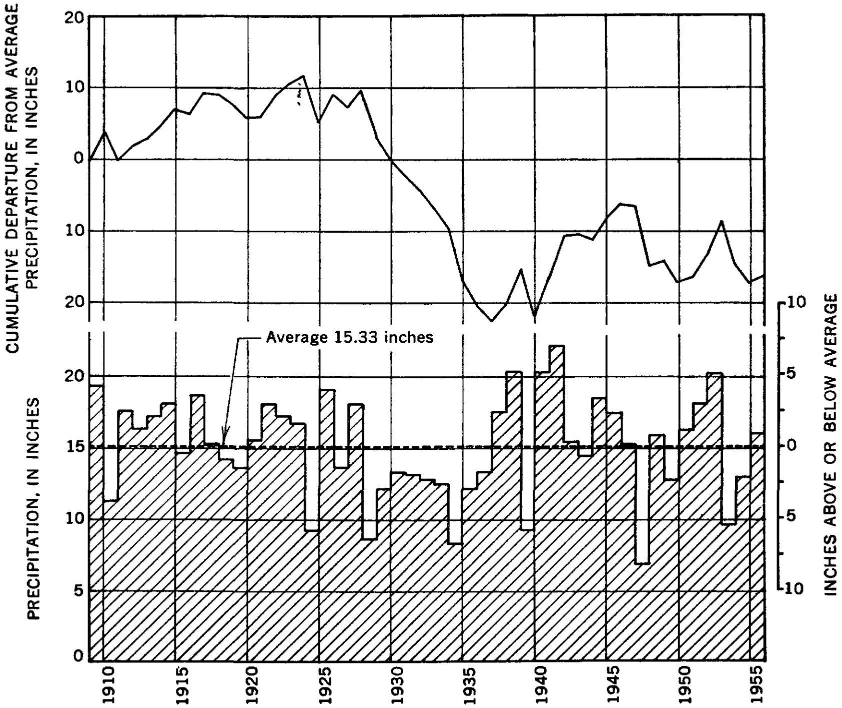

FIGURE 6.—Annual precipitation and cumulative departure from average at Hailey.

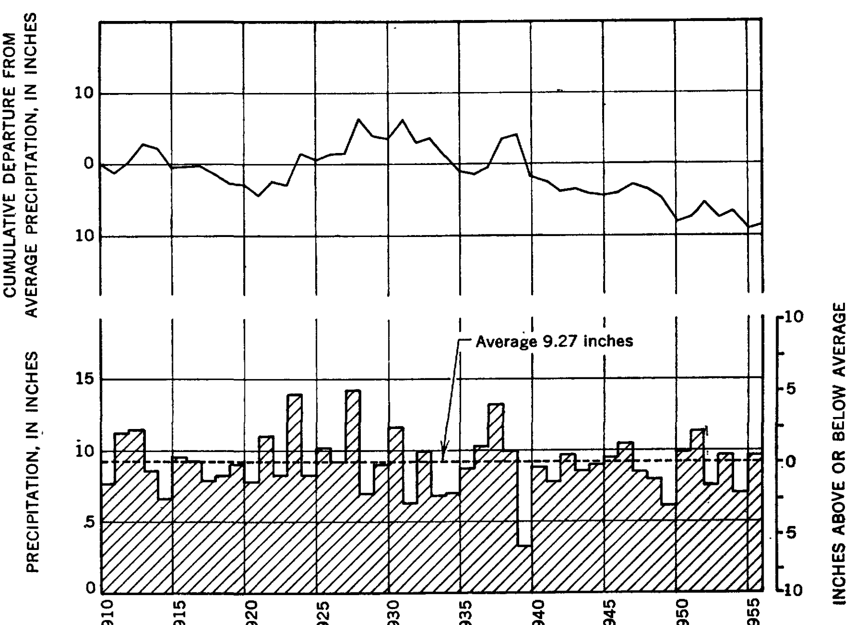

FIGURE 7.—Annual precipitation and cumulative departure from average at Gooding.

plain ranges from 47°F at Shoshone to 47.6°F at Gooding. The average length of the growing season is 118 days. Precipitation on the plain is light but during the growing season is fairly uniformly distributed. The average annual precipitation during 46 years of record ranges from 10.23 inches at Shoshone to 9.27 inches at Gooding.

The character of the vegetation in the mountainous part of the basin north of the Snake River Plain differs markedly with differences in altitude. In the lower less rugged parts of the area the slopes and valley floors are covered with shrubs and grasses, and there are very few coniferous trees. The banks of the Big Wood River and some of its tributaries are lined with cottonwood, willow, and alder. Trees become more abundant with increasing altitude but consist chiefly of groves of aspen and clumps of lodgepole pine at the middle altitudes. Evergreen trees predominate at the higher altitudes and on the northern slopes of ridges. Above 9,000 feet the forest growth is sparse and above 10,000 feet it is virtually nonexistent.

The Mount Bennett Hills, the Picabo Hills, and the uncultivated areas of the Snake River Plain support a considerable growth of native vegetation, chiefly sagebrush. In the areas receiving the smaller amounts of precipitation the natural growth includes desert-transition shrubs, but in areas receiving more precipitation an undergrowth of grass is associated with the shrubs.

AGRICULTURE

The principal agricultural activity in the Big Wood River basin is irrigation farming. In most years the surface-water supply is sufficient to irrigate the lands already developed, but shortages of water occur occasionally and ground water is pumped to provide supplemental water for some tracts, especially late in the irrigation season.

The acreage irrigated in the Big Wood River basin in 1950 was about 175,000, including lands irrigated by all waters naturally tributary to the Big Wood River basin as well as those served by water diverted from the Snake River at Milner Dam. Both row crops and small grain are irrigated, chiefly potatoes, beans, alfalfa, clover, oats, barley, and wheat. Large herds of cattle and sheep are raised on hay and natural pasture. About half the income of the area is derived from livestock.

WATER-BEARING PROPERTIES OF GEOLOGIC MATERIALS

The geologic features of the Big Wood River basin were examined only briefly during this investigation. For general geologic information reliance was placed chiefly on reports by earlier authors, principally Piper (1924), Umpleby and others (1930), and Stearns and others (1938). The outcrop areas of the various sedimentary formations and igneous rocks are shown on plate 2, which was compiled from all available sources of information. The physical characteristics and water-bearing properties of the rocks are briefly described below, with the principal emphasis on the formations having the greatest geologic and hydrologic significance in relation to gaging-station sites. In general, the younger and more permeable materials, such as Quaternary alluvial and fluvioglacial deposits and the Snake River basalt, are the more significant. They rest unconformably on various older rocks, some of which also are permeable.

PRECAMBRIAN SEDIMENTARY ROCKS

The oldest sedimentary rocks in the region are interbedded quartzite and limestone of Algonkian(?) type, which crop out in an area of about 20 square miles in the headwater areas of the East Fork of the Big Wood River and Hyndman Creek. These rocks, which are generally low in permeability, store and transmit little ground water.

SEDIMENTARY ROCKS OF PALEOZOIC AGE

Sedimentary rocks of Paleozoic age, which have an aggregate stratigraphic thickness of about 20,000 feet, crop out widely in the northern part of the region, chiefly in the mountainous area north of the Boise base line. In the rest of the basin, or in about half the total area, few rocks of older age than Cenozoic are exposed.

Sandstone and argillite of Ordovician age crop out in a belt that extends northwestward for 8 miles along the headwaters of Trail Creek, where they are in fault contact with other sedimentary rocks and themselves are cut by numerous faults. The rocks are generally low in porosity and permeability and have little capacity to store or transmit ground water except locally, where they are fractured and faulted. Silurian rocks, chiefly interbedded siliceous argillite and quartzitic sandstone, are exposed near the headwaters of Trail Creek. They are confined to a small area and are believed to be low in porosity and permeability.

Rocks that are believed to be principally of Carboniferous age have the greatest area of exposure, with outcrops in more than two-thirds of the upper Big Wood River basin. These rocks are steeply folded and faulted in most areas. At many places they are overlain by volcanic rocks and are cut by granitic stocks and dikes. Umpleby and others (1930) divided the Carboniferous rocks into two formations, the Milligen formation below and the Wood River formation above. The Milligen formation consists chiefly of carbonaceous black argillite with interbedded limestone, dolomitic limestone, quartzite, and a few beds of coal. The formation is Devonian(?) and Mississippian in age and is at least 3,000 feet thick. The Wood River formation, which is Pennsylvanian in age, consists of at least 8,000 feet of calcareous and quartzitic sandstone and conglomerate, shale, and dolomite. The basal member at most places is massive quartzitic conglomerate.

The rocks of the Wood River and Milligen formations are well consolidated, tightly cemented, and low in permeability and porosity. They are poor water-bearing rocks except where they are fractured and jointed. Under favorable conditions ground water is transmitted through the permeable zones and is discharged in springs. Two cold springs, with a combined discharge of about 780 gpm (gallons per minute), issue from Carboniferous(?) rocks at the State fish hatchery near Gannett. Hot springs issue from the sedimentary rocks at several localities, and seemingly, no two hot springs issue at exactly the same stratigraphic horizon. The largest hot spring, Guyer Hot Springs, which is on Warm Springs Creek 2 miles west of Ketchum, yields about 1,800 gpm through several nearly vertical joints in Carboniferous rocks.

INTRUSIVE ROCKS OF MESOZOIC AGE

Granitic rocks crop out at several places in the northern half of the Big Wood River basin. From their general petrologic character and geologic relations it is inferred that the rocks are genetically related to the Idaho batholith and may be physically continuous with it at depth. The rocks are believed to be early Cretaceous in age but they may be Jurassic. One of the largest outcrops is along the northeastern part of the basin near the headwaters of the Little Wood River and the East Fork of the Big Wood. The main mass of the rock is granodiorite, but there are substantial areas of quartz monzonite and a border facies of diorite.

Quartz monzonite borders the western side of the valley of the Big Wood River from near Bellevue southwestward to the backwater of Magic Reservoir. From there the monzonite extends northwestward to the headwaters of Willow Creek. Quartz monzonite also borders part of Camas Prairie on the north and south. Smaller bodies of granitic rock crop out in Deer Creek basin and in the area between Bellevue and the valley of Croy Creek.

The granitic rocks are cut by many joints, which locally yield sufficient ground water to supply perennial springs. There are several such springs near the western end of Camas Prairie. Near Bellevue small amounts of water come from mine tunnels in the granitic rock, and around the edge of Camas Prairie several hot springs also issue from this rock. Although Wardrop Hot Spring (pl. 2) issues from alluvium in Camas Prairie in sec. 32, T. 1 N., R. 13 E., suspended sediment in the water is coarse angular granitic debris that seems to come from granitic bedrock. The suspended sediment is quite different from the rounded grains of debris in the alluvium.

ROCKS OF CENOZOIC AGE

TERTIARY SEDIMENTARY ROCKS

East of Ketchum and northeast of Hailey, gravel and tuffaceous beds of Miocene(?) age are exposed in belts that trend north-northeastward. The tuffaceous beds are largely water laid. These rocks, which are interbedded with the Challis volcanics there and at many other places in the upper basin of the Big Wood River, are not very permeable and have little capacity to store and transmit ground water. In well 4N–18E–8bc1, which was drilled in this formation to obtain a public supply for Ketchum village, it is reported that the drawdown was 120 feet after 1 hour of pumping at a rate of 350 gpm. The yield is inadequate for municipal supply.

TERTIARY INTRUSIVE ROCKS

Stocks and large dikes of quartz diorite porphyry, Miocene(?) in age, are abundant near the headwaters of the Big Wood River and its North Fork. Because the permeability of these rocks is low, they are unimportant as a source of ground water.

TERTIARY VOLCANIC ROCKS

The Challis volcanics crop out in much of the upper basin of the Big Wood River, in most of the Little Wood River basin, and in the Picabo Hills. They are believed to be late Oligocene or early Miocene in age. These rocks, with an aggregate thickness of several thousand feet, are divisible into three groups: a lower series of augite andesite and basalt, a thick middle series of latite and hornblende andesite, and at some places an upper sequence of rhyolite flows. Beds of water-laid gravel and tuff locally are intercalated between the flows, which are tilted at angles of 10°–90°. The few faults that cut these rocks have only small displacements. The outcrops of Mount Bennett rhyolite extend from near Magic Reservoir through the Mount Bennett Hills to the western end of Camas Prairie. South of Camas Prairie the rhyolite is overlain by the Snake River basalt. The rhyolite is fine grained and porphyritic and is of late Miocene(?) age (Piper, 1924).

Where they are jointed and overlie relatively impermeable sedimentary beds, the Tertiary volcanic rocks probably are better aquifers than the older intrusives and consolidated sedimentary rocks. The Triumph mine on the East Fork of the Big Wood River was flooded in the winter of 1952–53 by an inflow of water at the 1,000-foot level from the contact between beds of Carboniferous age and overlying Tertiary volcanic rocks. The estimated rate of inflow was 3,000 gpm. Most of the water is believed to have come from the Tertiary rocks, from which perennial springs issue in the area north of the mine and at one place on the northeast edge of Camas Prairie (pl. 2). The rocks, however, have comparatively low porosity and permeability and store comparatively little ground water, except locally.

QUATERNARY VOLCANIC ROCKS

The southern third of the Big Wood River basin, from the Mount Bennett and Picabo Hills southward to the Snake River, is underlain by basalt flows. The basalt is believed to be chiefly Pleistocene in age, but the basalt in the Shoshone lava field is Recent in age. The Snake River basalt includes undifferentiated basalt of Pliocene to Recent age. Where it can be mapped separately, basalt of Recent age has been differentiated from the Snake River basalt. The rock texture ranges from dense to highly vesicular. Most of the flows have vertical columnar jointing, and many have extensive systems of fractures and thick fragmental zones. The basalt flows, which probably have an aggregate thickness of several thousand feet, have been but little disturbed by earth movements.

Basalt flows are present also in the Fish Creek and Little Wood River valleys, and these are believed to be contemporaneous with some of those in the Snake River Plain, although they originated from vents upstream in the valleys rather than from vents on the plain.

Large quantities of ground water are transmitted through joints and fractures in the basalt, through fragmental zones, and through other types of openings, including lava tubes. The importance and effectiveness of the basalt as a ground-water reservoir and conduit is illustrated by the copious discharge of water from springs in the canyon of the Snake River between Milner and Bliss. The average rate of discharge from those springs is more than 5,000 cfs (cubic feet per second).

QUATERNARY SEDIMENTS

Sediments of Quaternary age in the Big Wood River basin are glacial, fluvioglacial, alluvial, and wind deposited. Morainal material and remnants of high-level glacial outwash terraces are present along the upper valleys of the Big Wood and Little Wood Rivers and in some of their tributary valleys. These deposits and landforms were produced by alpine glaciation and melt water from glaciers during Pleistocene time. At lower levels in the northern mountain valleys, stream terraces and flood plains are underlain by gravel, sand, silt, and clay. The terraces are developed best in the valleys of the Big Wood and Little Wood Rivers. The terrace and flood-plain sediments are unconsolidated, and, in general, the material is poorly sorted to moderately well sorted.

Camas Creek basin is underlain by Recent alluvium except at its eastern end, in the area between Elk Creek and Brush Creek, where a body of older alluvium overlies the Snake River basalt and the older consolidated rocks. The older alluvium is poorly sorted gravel consisting of pebbles and boulders in a matrix of sandy clay. Pleistocene and Recent sediments are here described jointly as Quaternary sediments; the older alluvium is not discussed separately (see pl. 2). Unconsolidated light-colored loess and windblown sand of Recent age discontinuously mantle the basalt and older alluvium on much of the Snake River Plain. Locally the loess contains limy hardpan layers a few inches below the surface. The hardpan was produced by precipitation of calcium carbonate that was leached by percolating water from overlying loess.

The Pleistocene fluvioglacial sediments are quite permeable and are important aquifers where they occur in the mountain valleys. The gravel beneath alluvial terraces and flood plains is the most important aquifer in the mountain valleys, especially in the upper basin of the Big Wood River and in parts of Camas Creek basin. The gravel yields water abundantly to wells and at some places the water is confined under artesian pressure. The deposit of older alluvium at the eastern end of Camas Prairie is somewhat indurated and does not transmit ground water readily except through channel-gravel stringers that were deposited along the beds of former streams. These channel fillings yield large amounts of water to wells (Piper, 1924).

At some places on the Snake River Plain the loess contains intercalated lenses of windblown sand. Where the sand is in the zone of saturation it yields a small amount of water to wells. The most extensive sand deposits, however, are above the water table. In the irrigated areas of the basalt plain these sediments form the soil; thus, they are important in relation to artificial recharge of ground water from unconsumed irrigation water.

GEOHYDROLOGY OF SUBDIVISIONS OF THE BIG WOOD RIVER BASIN

For the purposes of description and discussion, the Big Wood River basin is somewhat arbitrarily subdivided into six geohydrologic districts (pl. 2) that are defined on the basis of geologic structure, topography, surface drainage, and occurrence of ground water.

The principal geohydrologic characteristics of these districts are outlined in this section, and descriptions of individual stations and evaluations of their records are given in the next section (p. 32).

In the following discussion the term, "water yield," is applied to the sum of surface runoff and ground-water underflow from a basin or district. The approximate percentage of the water yield that is ground-water underflow has been computed for three key stations. Key stations are those that measure the surface discharge from an entire district or subbasin and from which there is a reasonably continuous record of several years' duration. These computations were based on aquifer tests and field data, using the formula, $Q=PIA$ (Wenzel, 1942), in which Q is the quantity of ground water discharged by underflow in a unit period of time, P is the coefficient of permeability of the water-bearing material, I is the hydraulic gradient, and A is the cross-sectional area through which the water moves. When the complete saturated thickness of the aquifer is not tapped by a well being tested, and the value of A is not known, the formula may be modified to $Q=TIW$, in which T is the coefficient of transmissibility of the aquifer, I is the hydraulic gradient, and W is the average width of the aquifer. Values of P and T for sediments in the Bellevue district were determined by aquifer tests. The values of I for the Bellevue district were determined by instrumental leveling of the ground surface at wells and measurements of the depth to water. Estimated values for A and W, based on drillers' logs of wells, were used for the district. Using these determinations as a general guide, reasonable values of P and T were estimated for sediments elsewhere in the Big Wood River basin. For the other districts estimated values of I were assigned, using topographic maps as a guide, by assuming that the water table and the hydraulic gradient in the zone of saturation follow approximately the slope of the valley floor in the principal valleys. The values for A had to be estimated because direct information is not available about the cross-sectional areas of saturated material. Diagrams showing inferred geologic cross sections were prepared (fig. 8), based on general knowledge about shapes of the stream valleys, inferences from field examinations of the sites, and drillers' logs of wells near the sites. The inferred bedrock profile beneath the alluvial fill (solid line, fig. 8) then was generalized to form a triangle or trapezoid (dashed line, fig. 8), the area of which was computed.

The percentage of the water yield that is ungaged ground-water underflow was computed by comparing the estimated annual ground-water underflow in a stream valley with the sum of the average annual discharge of that stream for the whole period of record and the estimated annual ground-water underflow. In a given water

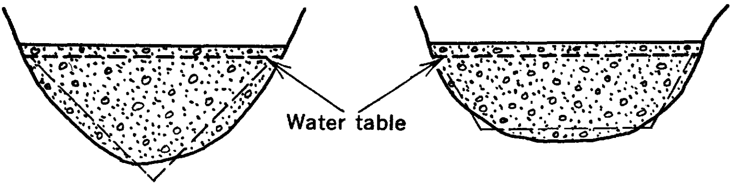

FIGURE 8.—Method of measuring inferred cross-sectional areas, using triangular and trapezoidal approximations of saturated area.

year, of course, the percentage may vary from a relatively negligible amount of the water yield during months of high surface runoff to a relatively large amount during months of low flow.

Because large errors are inevitable, the method used for estimating the underflow is very unsatisfactory. However, the estimates are believed to indicate the approximate relative order of magnitude of the underflow component of water yield and to serve a more useful purpose than would be accomplished by simple qualitative statements that much, a small amount, significant amounts, or other vague quantities of underflow are inferred.

KETCHUM DISTRICT

The Ketchum district (1, pl. 2) includes the mountainous main stem and tributary headwaters area of the Big Wood River above the town of Hailey, where the principal source of runoff is melting snow. Much of the district is underlain by volcanic rocks and well-consolidated sedimentary rocks which are low in permeability. However, the floors of the valleys of the Big Wood River and its principal tributaries are underlain mostly by coarse, permeable alluvium.

Runoff from the Ketchum district is into the main stem of the Big Wood River. Contributions from important segments of the district are gaged at station 1 on the main stem and at station 3 on Warm Springs Creek. An appreciable part of the water yield of the district is discharged by underflow through the permeable alluvium beneath the valley floor. Gage records show that at successive downstream stations the discharge of the Big Wood River increases steadily in amounts greater than the surface contributions from tributary streams. That increase is ground water that is discharged to the surface stream from the saturated alluvium, in which the water table is above the level of the river. Although the records show a net gain in surface discharge downstream, underflow increases and becomes an appreciable part of the total water yield. From station 1, where the estimated underflow is more than 10 percent of the water yield, the percentage of underflow seems to remain about the same down valley to Hailey, where it is still about 10 percent of the total. Thus, surface runoff past station 7 at Hailey probably is about 90 percent of the total water yield of the Ketchum district.

BELLEVUE DISTRICT

Conditions in the valley of the Big Wood River below Hailey differ markedly from those in the Ketchum district. The Bellevue district (2, pl. 2) includes the main stem of the Big Wood River between Hailey and Magic Reservoir, as well as the drainage areas of Croy, Rock, Silver, Quigley, Slaughterhouse, and Seamans Creeks. Runoff from the latter three creeks sinks into the alluvium along the border of the floor of the Big Wood River valley and recharges the local ground-water reservoir. Seemingly, water rarely reaches the Big Wood River at the surface in these creek channels. The channel of Croy Creek joins the Big Wood River at Hailey and that of Rock Creek enters Magic Reservoir below station 9. The ground-water contribution from the two creek valleys is believed to be small.

Below Bellevue the valley of the Big Wood River widens to a broad triangular basin that is underlain by a considerable thickness of alluvial and fluvioglacial sediments. During accumulation of some of the sediments the Big Wood River presumably discharged through a channel around the east end of the Picabo Hills, at or near the present course of the lower reach of Silver Creek. Later, the old channel of the Big Wood was blocked and the river established a new course around the west end of the Picabo Hills. The drainage changes were influenced or controlled by basaltic lava flows that spread toward the mountains from vents on the Snake River Plain. Silver Creek, a spring-fed stream, rose where the water table in the valley sediments intersected the land surface, and the creek found an outlet along or near the older lower course of the Big Wood.

The consolidated rocks that crop out around the borders of the district form a floor beneath the alluvial and fluvioglacial sediments in the Bellevue district. The thickness of the sediments is not known. Well 1S–19E–8cd1 is 244 feet deep but does not reach the bedrock floor beneath the valley. The permeability of the basement rocks is low and they probably transmit very little ground water by underflow through the district.

The record for gaging station 8, below Bellevue, probably represents a smaller percentage of water yield than any other station in the northern part of the Big Wood River basin. Between stations 7 and 9 where a large part of the water is discharged by underflow beneath and around the river channel, some of the ground water is diverted from the basin of the Big Wood River main stem to the basin of Silver Creek and thence to the Little Wood. Irrigation wells along the Boise base line, southeast of station 8, withdraw substantial amounts of water from the alluvium (pl. 2 and table 2). Between Bellevue and a point about 5 miles south of Bellevue the river loses water by percolation into the alluvium. A bypass canal which diverts about 18 cfs of water, was constructed around the lower part of this reach to salvage water that otherwise would be lost to the ground. Between the lower end of the bypass canal and Magic Reservoir the river gains water from the ground. Much of the gain is from spring-fed creeks that rise in the alluvium and enter the river a short distance upstream from station 9.

A ground-water divide extending southward through the district separates the ground-water body into two parts. The western part is tributary to the Big Wood River main stem and the eastern part is tributary to Silver Creek and the Little Wood. The approximate location of the divide (pl. 2) was plotted from Chapman's water-table contour map for 1921. There are seasonal shifts in the divide, depending on the stage of the river and the status of diversions for irrigation and there may have been a permanent net shift since 1921, but the general location of the divide is unquestioned. Evidently, much water originating in the upper basin of the Big Wood River moves southeastward on the east side of the divide and leaves the main stem drainage. Some of the water subsequently appears near the base of the Picabo Hills in the springs and seeps that give rise to Silver Creek.

Silver Creek derives practically all of its water from the ground-water reservoir. Part of the ground water is derived from infiltration of unconsumed irrigation water in the upstream part of the area occupied by alluvium. A smaller amount, derived from surface runoff from the mountains on the northeast and from the Picabo Hills on the south, sinks into the alluvium around the borders of the basin. The months of highest runoff in Silver Creek are April, July, August, September, and October.

Artesian water occurs in the southwestern part of the Bellevue district, where flowing artesian wells in a small area west of the ground-water divide have a combined yearly yield of about 13,200 gpm (pl. 2 and table 2). A few flowing wells are east of the divide. Several geologic and hydrologic factors contribute to the artesian conditions. Drillers' logs of wells reveal a gradational change in the character of the alluvium, from sand and gravel with only traces of clay north of the Boise base line, to layers of clay interbedded with the sand and gravel south of the base line. The artesian aquifers are beds of fine- to medium-grained gravel in a sand matrix, in which water is confined under pressure by beds of relatively impermeable clay. The beds dip gently southward and recharge is largely from the north, so that the pressure gradient also is generally southward.

Gaging station 9, on the Big Wood River just above Magic Reservoir, and station 24, on Silver Creek, together record the total surface runoff from the Bellevue and Ketchum districts. The amount of ungaged water that passes station 9 as underflow probably is negligible. Geohydrologic evidence indicates, however, that a substantial amount of water escapes from the Bellevue district as ungaged underflow through sand and gravel formations that are interbedded with flows of Snake River basalt at the southeastern outlet of the district. The ground water probably first enters these aquifers where they interfinger with confining clay beds in the vicinity of the Boise base line. The water not discharged through springs or pumped from wells moves southeastward to the vicinity of Picabo. From Picabo the ground water moves on through sand and gravel beds that interfinger with basalt flows (see log of well 2S–20E–1ac1, p. 63) and joins the regional body of ground water in the basalt of the Snake River plain. Some of the alluvial aquifers probably are continuous from the base line to where they are interbedded with the basalt flows near Picabo. Others may terminate northwest of Picabo, at the basalt cone, which is itself a good aquifer (see pl. 2 and log of well S–20E–19ac1, p. 62), or they may thin and disappear before reaching the basalt-flow fronts. Data obtained during an aquifer test of well 2S–20E–1ac2, near gaging station 24, indicate that underflow through one such alluvial aquifer is between 20 and 25 percent of the water yield from the Silver Creek basin and between 5 and 10 percent of the combined yield of the Ketchum and Bellevue districts.

In addition to the underflow through deeper aquifers from the Silver Creek area, an undetermined but appreciable amount of water escapes from Silver Creek by running into openings in its basalt-floored channel and flood plain upstream from station 24. The water that escapes as described above is not gaged as it leaves the Bellevue district and the combined records from stations 9 and 24, therefore, do not represent the water yield of the Ketchum and Bellevue districts. An accurate estimate of the water yield from the area above the two gaging stations would require detailed study of climate, surface runoff, evapotranspiration, and ground water, but such a study is beyond the scope of this report.

FAIRFIELD DISTRICT

The Fairfield district (3, pl. 2) coincides with the Camas Creek drainage area, a topographic and structural basin that is partly filled with alluvium derived from the mountain masses to the north and west and from the Mount Bennett Hills to the south. During the Pleistocene epoch eruptions of Snake River basalt blocked the eastern outlet of the basin. Owing to the low average gradient of Camas Creek (about 5 feet per mile), downcutting by the creek is relatively slow and its transporting capacity is limited. Similar conditions have prevailed since the episode of volcanism. Much of the alluvial fill in the basin probably accumulated while Camas Creek was cutting a new channel in the basalt barrier and was unable to remove all the sediment that was brought to it by its tributary streams. The Big Wood River, which also was cutting down only slowly, functioned as a local base level for the Camas Creek basin. Hence the creek did not reexcavate the older alluvium, and deposition of additional alluvium continued to the present time.

Consolidated rocks crop out in Camas Creek basin in the mountainous areas that surround Camas Prairie. The rocks are present also at unknown depth beneath the alluvium of the prairie and at one time formed the deep valley of an ancestral stream that flowed eastward. The ancient valley, carved from rocks having low permeability, now forms a nearly watertight floor beneath the alluvium, and that floor acts as a control to the movement of ground water. Older alluvium, which forms the main mass of sediments beneath the prairie and crops out in the eastern part, is overlain by younger alluvium, which occurs chiefly in broad, coalescing alluvial fans extending southward from the northern mountain front. The alluvial deposits, which are poorly sorted, grade from coarse debris at the base of the northern mountain front to lenses and sheets of clay, sand, and fine-grained gravel along the stream courses farther south. The most productive aquifers are sand and gravel.

In the Camas Creek basin water under artesian pressure is obtained from aquifers ranging from 200 to 450 feet below the land surface. The deepest well in the basin, 1S–14E–10ca1, is 447 feet deep (table 2). The aquifers and the confining beds of relatively impermeable clay dip southeastward approximately parallel to the land surface. The alluvium along the northern flank of the prairie is saturated, and, inasmuch as confining clay beds are absent in that area, water can percolate rather freely downward to the base of the alluvium. As the water moves downdip, lenses of clay from the southeast confine it in some layers (fig. 9). The shallow alluvium also contains unconfined ground water and yields water to pumped wells throughout the basin.

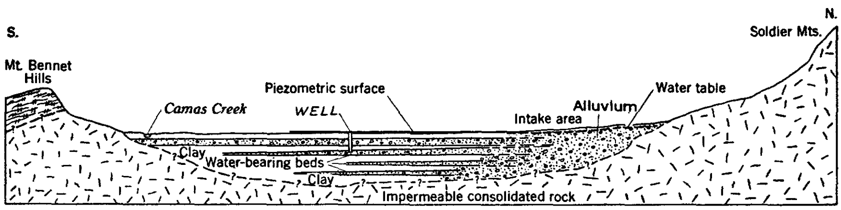

FIGURE 9.—Hypothetical cross section of Camas Creek basin, illustrating artesian conditions. Not to scale; adapted from Piper (1924).

Geologic evidence indicates that ground water may leave the Fairfield district by underflow through the Snake River basalt in the vicinity of the reach of Camas Creek just above gaging station 10. The Camas Creek basin is structurally and physiographically similar to the Silver Creek basin, from which ground water is discharged by underflow through sand and gravel formations that are interbedded with flows of Snake River basalt (see discussion of aquifer test, p. 53). Ground water possibly escapes by similar means from the Camas Creek basin. Ground water in alluvial beds between flows of basalt and in joints and other openings along flow contacts in the basalt upstream from gaging station 10 would pass by underflow into the Snake River basalt in the Richfield district. Piper (1924, p. 31–32) believed that part of the ground-water supply of the basin escapes by deep percolation to the southeast. Lack of records of streamflow and upstream diversions makes it impossible to estimate the amount of subsurface loss.

MULDOON DISTRICT

The Muldoon district (4, pl. 2) includes the drainage area of the Little Wood River above station 20, and most of the drainage area of Fish Creek, which is included arbitrarily in the district for purposes of this report. The district is mountainous and most of the runoff is from melting snow. A canal diverts all of the water from Fish Creek to irrigated land north of Carey, and surplus water from the canal discharges into the East Canal of the Little Wood River (pl. 2).

Much of the area is underlain by volcanic and consolidated sedimentary rocks of low permeability. Basalt and permeable alluvium of Quaternary age underlie much of the valley floor of the Little Wood River and Fish Creek and strongly influence the runoff at gaging stations. The basalt flows are contemporaneous with the Snake River basalt (Umpleby and others, 1930, p. 61), which they resemble in physical characteristics. A sequence of the flows, which apparently originated in the vicinity of former station 18, extends down the valley of the Little Wood River to a point just below station 20. Test holes drilled by the U.S. Bureau of Reclamation near the dam of Little Wood Reservoir, between stations 19 and 20, indicate that the basalt overlies an older alluvial deposit of unknown thickness (see log of well 1N–20E–12cc1, p. 60). Similar flows, which probably originated at vents near the site of gaging station 23, extend down the valley of Fish Creek to the Snake River Plain. The Little Wood River and Fish Creek were dammed by these basalt flows and both streams deposited gravel, sand, and clay upstream from the basalt barrier before cutting into the basalt the deep, narrow gorges which they now occupy. Coarse, permeable alluvium underlies the floors of both gorges.

Conduits for ground-water underflow are provided by the permeable alluvium on floors of the gorges, by open joints and voids along flow contacts in the basalt, and by permeable old alluvium beneath the basalt. The older alluvium was found to contain large amounts of ground water where the alluvium was reached by test holes for the Little Wood River Dam; the lower part of the basalt also was found to contain abundant water. Ground water moves down the valleys of both the Little Wood River and Fish Creek and, of course, is not gaged at stations 19, 20, or former station 23. An appreciable amount of water passes station 19 as underflow through basalt and alluvium. It is estimated that between 5 and 10 percent of the water yield from above station 20 is underflow. About 10 to 15 percent of the yield from the Fish Creek drainage area percolates into openings in the basalt floor of Fish Creek reservoir and bypasses the site of station 23 as underflow through the basalt. Part of the water returns to Fish Creek through springs downstream from the station and the remainder sinks into the Snake River basalt near the mouth of the valley of Fish Creek.

RICHFIELD DISTRICT

The Richfield district (5, pl. 2) is bounded on the north by hills and mountains which separate the mountainous northern districts of the Big Wood River basin from the geologically and hydrologically different southern districts on the Snake River Plain. The Richfield district is roughly delineated on the southeast by the boundary of surface-water drainage into the Little Wood River, and on the southwest by an arbitrary boundary which excludes the area served by the Milner-Gooding Canal with water imported from the Snake River.

Most of the district is underlain by Snake River basalt, although spurs of Tertiary silicic volcanic rock extend into the northern part of the district, and Recent basalt flows occur in the central part. Coarse alluvium underlies the floor of the Little Wood River valley below station 20 and overlies the Snake River basalt in the vicinity of Carey.

The Richfield district is of special importance in the evaluation of gaging-station records because large amounts of water percolate into the Snake River basalt from the channels of the Big Wood and Little Wood Rivers where they cross the Snake River Plain. A considerable amount of water from the rivers percolates into the basalt also from canals and irrigated fields. The greatest channel losses occur in the reach of the Big Wood River between gaging stations 11 and 13, in the Little Wood River between stations 20 and 25, and in Silver Creek between station 24 and the confluence of Silver Creek with the Little Wood River.

Before 1909 there presumably was considerable flow throughout the year in the Big Wood River past the site of gaging station 11 at the northern margin of the Richfield district. With construction of Magic Dam in 1908–09 and storage of water in the reservoir, the regimen was considerably changed. During fall, winter, and early spring months, little water discharged past station 11, and the little that did pass this station was lost within a short distance downstream so that the channel was essentially dry for a distance of some 40 miles downstream to the site of gaging station 16, near Gooding. During the irrigation season, however, there was considerable flow past station 11 as water was released for downstream irrigation. A large part of the water released was lost by percolation from the channel between station 11, immediately below the reservoir, and station 13, west of Richfield. Records of the watermaster show that the channel loss in the reach between stations 11 and 13 increased from an average of 40.5 cfs during the irrigation seasons of 1917–19 to an average of 149 cfs during the irrigation seasons of 1920–25. Since 1925 the entire natural flow of the Big Wood River has been diverted through the Lincoln Canal (pl. 2) past that reach of the river which sustains the largest losses. During the period 1925–52 the average infiltration loss from the canal between stations 11 and 13 was 55.1 cfs.

During April, July, August, September, and October, the months of high runoff in the Silver Creek basin, water flows into openings in the Snake River basalt at numerous places along the creek, just above its junction with the Little Wood River. During these months of high runoff, from 1919 to 1952, an apparent average of 17 cfs was lost from the channels of Silver Creek and the Little Wood River in the reach between stations 24 and 25. This reach receives surface flow from the upper part of the Little Wood River only during years of high runoff. Since 1923 all the natural flow of the

507213—60——3

upper Little Wood River has been diverted through its east and west canals and waste irrigation water has been allowed to percolate from irrigated lands into permeable alluvium and basalt upstream from the confluence of the river and Silver Creek. The watermaster reports that prior to installation of these diversion works a large amount of water was lost from the channel of the river by seepage in a reach of coarse gravel in the vicinity of Carey. In the reach of the Little Wood River between stations 25 and 26 the apparent average loss (flow at station 25 minus flow at station 26) was only 7.8 cfs during the period 1921–52. That rate of loss, however, is not the actual channel loss in the Little Wood River because water is diverted from the river for irrigation, and waste water flows into the river from the Big Wood River and from irrigation in adjacent areas. The magnitude of the infiltration losses from irrigated lands in the Richfield district is not known.

Most of the surface water that seeps into the ground in the Richfield district joins the regional body of ground water in the Snake River basalt, and passing by underflow out of the district, does not reappear as return flow to the Big Wood River within the district.

Records from gaging stations in this district indicate the surface flow at given points, but owing to the great volume of groundwater underflow, station records do not accurately indicate the water yield of the basin. Indeed, the concept of water yield, as applied to the Big Wood River basin, has little bearing in the Richfield district. In much of the district the streams are from tens to hundreds of feet above the permanent water table and large quantities of water are lost by percolation between stations so that gaging stations can do no more than furnish a record of point discharges, diversions, and percolation losses. The ground water contributed by these percolation losses and by underflow from the northern districts of the basin loses its identify by merging with a regional body of ground water that underlies many thousands of square miles of the Snake River Plain.

GOODING DISTRICT

The Gooding district (6, pl. 2) is bounded on the north by the Mount Bennett Hills, and on the west by a natural drainage divide formed by unnamed hills. The eastern boundary has been established arbitrarily just east of the Milner-Gooding Canal to encompass all the area served by imported water from the Snake River. The southern boundary coincides approximately with the southern limit of the irrigated area that is served wholly or partly with water from the Big Wood and Little Wood Rivers. The segment of the Snake River Plain south of the southern boundary is not a part of the Big Wood River basin but is included on the map (pl. 2) to show the regional uniformity of the geology and to portray some of the complicated hydrology introduced by importing Snake River water through the Milner-Gooding and Twin Falls North Side Canals.

The district is underlain by Snake River basalt. The central part is underlain by the geologically Recent Shoshone lava field. The Recent basalt occupies a narrow arcuate belt extending from the vicinity of the Picabo Hills past Shoshone and nearly to Gooding. Older flows of the Snake River basalt have a gently rolling surface which is mantled discontinuously by windblown sand and silt.

The Big Wood River and the Little Wood River follow opposite edges of the Shoshone basalt flow from near Burmah and Richfield to Gooding; they join 4½ miles west of Gooding. Thorn Creek and Dry Creek drain part of the Mount Bennett Hills and join the Big Wood River in this district.

Large amounts of water percolate into the basalt from stream channels and irrigated lands in the Gooding district. The apparent channel loss in the reach of the Big Wood River between former stations 13 and 16, flow at station 13 minus flow at station 16, averaged 68.7 cfs during the period 1917–27. Since 1916 most of the flow of the river has been diverted through the North Gooding Canal to irrigate a belt of land parallel to this reach of the river on the north. Thus, the river channel retains only the water that is not required for canal diversion, plus an unknown amount of return flow from irrigation. The reach of the river between former station 16 and station 27 had an apparent average loss of 9.6 cfs from the channel during the period 1917–30. Since 1916, however, that reach has contained water imported from the Snake River through the Twin Falls North Side Canal. During the period 1921–30 the apparent average rate of channel loss in the Little Wood River between station 26 and Gooding was 27.2 cfs. Since 1931, water imported from the Snake River through the Milner-Gooding Canal has entered both the Big Wood and Little Wood Rivers in the Gooding district and channel-loss figures thus are not represntative of actual loss from the river channels.

Many deep wells produce large supplies of water from the basalt. Well 6S–17E–2ab1, in Shoshone, reportedly produces 1,350 gpm (table 2). Stearns (1938, p. 261) estimated that, in the period 1920–27, 354,000 acre-feet—about 83 percent of the measured surface-water discharge from the mountainous northern half of the Big Wood River basin—percolated annually into the Snake River basalt and reached the Snake River Plain as ground-water underflow. That estimate did not take into account the water lost by evapotranspiration from ponded bodies of water and nonirrigated land in the Ketchum, Bellevue, Fairfield, and Muldoon districts, nor the quantity of ground water that bypasses gaging stations 11, 20, and 24, and the site of station 23. Nevertheless, Stearns' estimate does indicate roughly the amount of ground-water underflow through the Richfield and Gooding districts.

Much ground water enters the Big Wood River downstream from station 27, where the river flows through Malad canyon. In that reach, from the mouth of the Big Wood River to a point about 3 miles upstream, ground water is discharged from springs at a rate of about 1,100 cfs.

In the Gooding district, ground water contributed by underflow from other parts of the Big Wood River basin and by percolation losses of surface water loses its identity by merging with the regional body of ground water that underlies the Snake River Plain. The concept of water yield has little application within the Gooding District for the same reasons that were set forth in the discussion of the Richfield district.

GEOHYDROLOGIC APPRAISAL OF GAGING-STATION RECORDS

Descriptions of individual gaging stations and geohydrologic evaluations of their records are contained in the following discussion. No attempt is made to combine this evaluation with the evaluation of the effects of upstream diversions presented in the companion report by Jones (1952). The reader should refer to both reports when appraising the water yield of the area upstream from a gaging station.

PROCEDURE

The system of numbering gaging stations used in the report by Jones (1952) is retained in this report. Stations on the Big Wood River and its tributaries (pl. 2) are numbered in downstream order from the headwaters to the mouth, with stations on the tributaries numbered in the order in which the tributaries enter the trunk stream.

In the following description, "drainage area" is the entire surface-drainage area above the gaging station within the topographic divides of the basin. Where the drainage area is not stated the information is not available. The paragraph "records available" indicates the period for which discharge records are known to be available. The records for which the source is not shown are published by the U.S. Geological Survey in its series of water-supply papers. "Topography" includes natural and manmade features, in the vicinity of the gaging stations, that may affect the gaging-station records. The paragraph "geology" describes the geology in the immediate vicinity of the gaging station, with emphasis on geologic factors that may appreciably affect the movement of ground water and the loss of water by infiltration in stream channels.

Ground-water withdrawal from the drainage area above a station, including withdrawal from ungaged springs, is discussed qualitatively only insofar as it probably affects the adequacy of station records in indicating water yield. The available data on ground-water pumping are quite inadequate, and for most stations on the Snake River Plain comments about ground-water pumpage are omitted.

Imported recharge is the contribution of Snake River water to recharge of the ground-water reservoir in the lower part of the Big Wood River basin. The water is imported through the Milner-Gooding and Twin Falls North Side Canals, into which water is diverted from the Snake River at Milner Dam.

"Ground-water underflow" applies to all ground water moving by underflow beneath or past gaging stations, and to the ground water which flows beneath surface-drainage divides from one drainage basin to another. An estimate of the quantity of ground-water underflow is possible only in a few instances. The term has no value in discussions of records from stations in the Richfield and Gooding districts. In those areas most of the ground water is part of the regional body that underlies the entire Snake River Plain and that receives recharge from many thousands of square miles outside the Big Wood River basin. Therefore, discussion of the ground-water underflow is omitted, except in a restricted local sense, for most of the stations in the Richfield and Gooding districts.

The paragraph "adequacy of record" applies an adjectival rating which indicates roughly the degree to which a gaging-station record approaches a measure of the water yield of the basin above the station. "Downvalley flow" is the flow, both surface and subsurface, that passes the gaging site. It includes underflow around and beneath the site but does not include water that leaves the basin upstream from the site either as underflow or as surface diversion. The ratings are relative. For example, if ground-water underflow is believed to be within the limits of accuracy of the gaging-station record, the record is rated as an "adequate" measure of the water yield of the basin above the station. If the percentage of ground-water underflow is believed to be more than this but within 10 percent of the water yield, the record is rated as "fairly adequate." Where geologic evidence indicates that over 10 percent of the water yield is ground-water underflow, the record is rated as "not adequate." The ratio of surface runoff to ground-water underflow varies, of course, with the stage of a river, being higher in times of high runoff than it is in periods of low runoff.

Accurate data on the water yield, especially in the northern districts of the Big Wood River basin, may be needed in the future. Because of ungaged ground-water underflow some key areas in the northern districts contain no sites at which a surface-water record would reflect adequately the water yield. The ground-water component of water yield at key gage sites could be accurately computed by drilling test holes to determine the saturated thickness of the alluvium and the profile of the bedrock beneath the alluvium and by making aquifer tests to determine the coefficient of transmissibility of the aquifer. Such measurements of the quantity of ground-water underflow, made in conjunction with gage records of surface-water flow, could be used to compute the water yield of the northern districts.

DESCRIPTION OF GAGING STATIONS

[Numbers of gaging stations refer to numbered stations on plate 2]

STATION 1. BIG WOOD RIVER NEAR KETCHUM

Station location.—Recording gage in sec. 4, T. 5 N., R. 17 E., half a mile upstream from the mouth of the North Fork, and 8 miles northwest of Ketchum.

Drainage area.—137 sq mi.

Records available.—May 1948 to date.

Topography.—The valley is bounded on both sides by steep mountain slopes. From a narrow gorge 1¾ miles upstream the valley widens to ½ mile at the station, and narrows again ⅓ mile downstream. Most of the valley floor is nearly flat, except for gravel bars and shallow channel scars; on the east side of the valley, remnants of older gravel terraces stand about 100 feet above the floor. The river flows along the west side of the valley.

Geology.—Impermeable rocks of the Wood River formation are exposed in both sides of the valley (fig. 10). The valley floor is underlain by fluvioglacial and alluvial silt, coarse sand, and pebble- to boulder-sized gravel. The river channel is incised in the sediments and contains angular blocks of rock. The thickness of the sediments is not known but is estimated to be at least 250 feet (fig. 10).

Ground-water underflow.—Ground water moves down the valley through unconsolidated sediments. Two shallow wells northeast of the station yield water readily by hand pump. The ground-water component probably is more than 10 percent of the water yield.

Adequacy of record.—The record is not an entirely adequate measure of the water yield of the headwaters area of the Big Wood River. Depending on the thickness of the alluvium the records may be either inadequate or fairly adequate.

STATION 2. BIG WOOD RIVER AT KETCHUM

Station location.—Staff gage in the SE¼ sec. 12, T. 4 N., R. 17 E., half a mile above the mouth of Warm Springs Creek and 1½ miles above the mouth of Trail Creek.

Records available.—May 1920 to September 1921, when station was discontinued.

Topography.—The valley is about two-thirds of a mile wide and is bounded on both sides by moderately steep mountain slopes. A well-defined system of river terraces extends along both sides of the valley. Remnants of older,

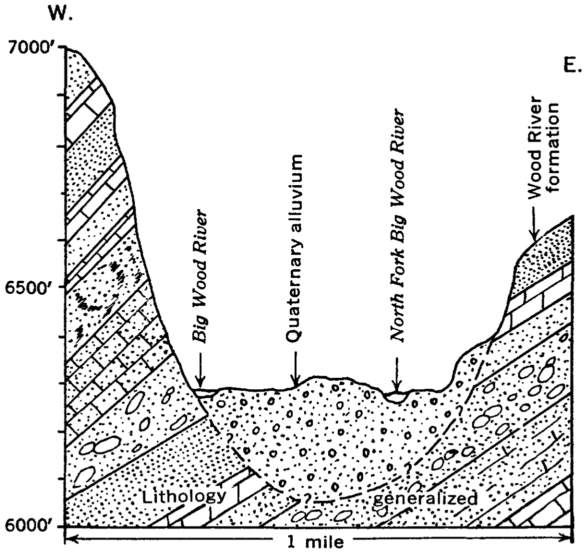

FIGURE 10.—Inferred geologic section at the site of gaging station 1, Big Wood River near Ketchum. (Datum is sea level; note vertical exaggeration.)

higher gravel terraces occur around the mouth of the valley of Warm Springs Creek. The Big Wood River in this reach flows southward near the west side of the valley, and its channel is incised a few feet below the general level of the valley floor.

Geology.—The Wood River formation and Challis volcanics crop out in the west side of the valley, and the Challis volcanics crop out on the east. The valley floor is underlain by an undetermined thickness of gravel which contains a large proportion of well-rounded to subrounded cobbles and boulders. At the station site Challis volcanics crop out in the east bank of the river (fig. 11).

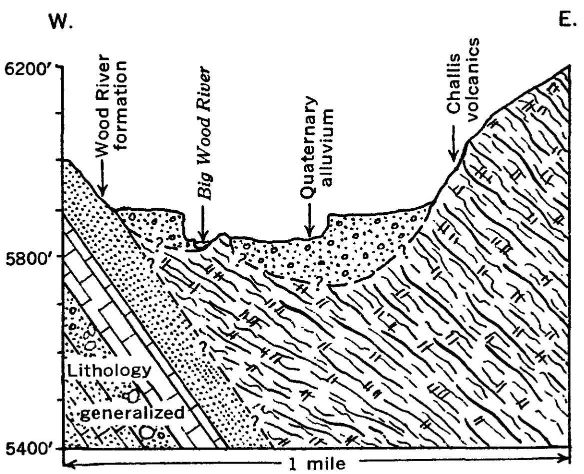

FIGURE 11.—Inferred geologic section at the site of gaging station 2, Big Wood River at Ketchum. (Datum is sea level; note vertical exaggeration.)

Ground-water underflow.—A substantial amount of ground water moves down the valley through the coarse sand and gravel beneath the valley floor. Well 4N–17E–13aa1, 2,000 feet southeast of the site, reportedly yielded 300 gpm of water pumped from the sand and gravel during a yield test. Domestic wells half a mile below the gage site, in the village of Ketchum, obtain adequate supplies of water from the underlying coarse sand and gravel, which is saturated at shallow depth. The irregularity of the bedrock floor beneath the alluvium makes it impossible to estimate, even approximately, the percentage of the water yield that passes the gage site by underflow through the gravel. The ungaged ground-water underflow probably is a substantial percentage of the water yield.

Adequacy of record.—The record is not believed to be an adequate measure of the water yield of the basin above the gage.

STATION 3. WARM SPRINGS CREEK AT GUYER HOT SPRINGS, NEAR KETCHUM

Station location.—Recording gage in the NE¼ sec. 15, T. 4 N., R. 17 E., at Guyer Hot Springs, 2⅛ miles upstream from the mouth of Warm Springs Creek, and 2¼ miles west of Ketchum.

Drainage area.—96 sq mi.

Records available.—November 1940 to date.

Topography.—Warm Springs Creek in this reach flows eastward along the south side of a narrow canyon. The valley floor is about 500 feet wide and is bounded on both sides by high, steep mountain slopes.

Geology.—Both sides of the canyon are formed by rocks of the Wood River formation. A hand-auger hole sunk in the valley floor near the station shows about 2½ feet of silt, sand, and fine gravel, underlain by coarse gravel. The stream channel is paved with sand and subrounded to well-rounded pebbles, cobbles, and boulders, mixed with angular blocks of limestone (fig. 12).

Ground-water withdrawals.—A cold spring discharges about 40 gpm of water at a point on the valley floor about 600 feet northwest of the station; the water bypasses the gage and enters the creek about 120 feet downstream. Hot springs, with a reported aggregate discharge of 1,800 gpm, issue from vertical joints in the Wood River formation in the valley wall opposite the station. Most of the discharged water is diverted above the station and piped to Ketchum; then it is returned to Trail Creek downstream from station 5.

Ground-water underflow.—Underflow is believed to be negligible owing to small cross-sectional area of alluvium; underflow probably is less than 1 percent of the water yield.

Adequacy of record.—The record is an adequate measure of the water yield of the drainage area of Warm Springs Creek.

STATION 4. WARM SPRINGS CREEK NEAR KETCHUM

Station location.—Staff gage in sec. 15, T. 4 N., R. 17 E., 2 miles upstream from the mouth of Warm Springs Creek and 1¾ miles west of Ketchum.

Records available.—May 1920 to September 1921, when station was discontinued.

Topography.—The valley widens abruptly from about 500 feet at Guyer Hot Springs to about 1,000 feet in the vicinity of the gage site and is bounded on both sides by steep mountain slopes. Gravelly stream terraces, rising about 16 feet above the valley floor, extend along both sides of the valley. Warm Springs Creek flows eastward in this reach and its channel is incised from 3 to 4 feet below the general level of the valley floor.

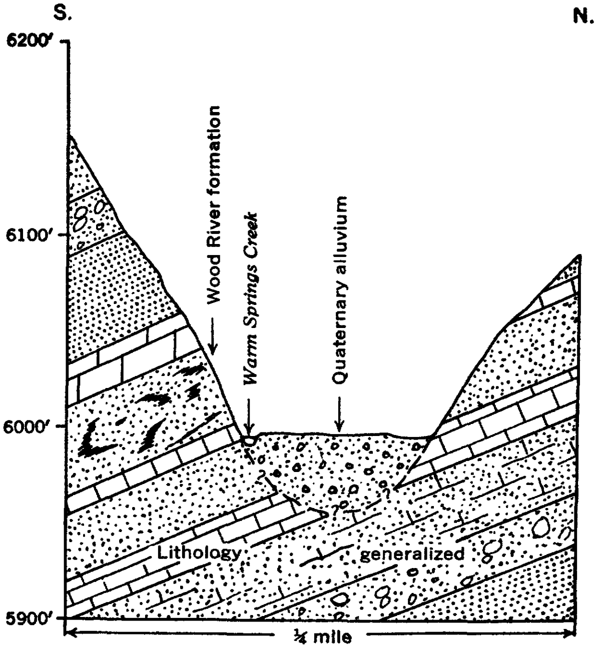

FIGURE 12.—Inferred geologic section at the site of gaging station 3, Warm Springs Creek at Guyer Hot Springs, near Ketchum. (Datum is sea level; note vertical exaggeration.)

Geology.—Both sides of the valley consist of impermeable rocks of the Wood River formation. The alluvial fill on the valley floor consists of moderately well rounded pebble, cobble, and boulder gravel, interbedded with lenses of sand and silt. Two beds of well-cemented gravel are exposed in the stream bank 500 feet upstream from the site. Well 4N–17E–15aa1, 500 feet upstream from the site, extends through the gravel to bedrock at a depth of 37 feet (well log, p. 58).

Ground-water withdrawals.—Hot springs discharge water from both banks of the creek and in the channel reach extending from the gage site 500 feet upstream, where a hot spring discharges 36 gpm from the alluvium 4 feet above the level of the stream. Part of the water discharged from one of these hot springs near the gage site is piped across the river for private use and the remainder empties into the stream 50 feet downstream.

Ground-water underflow.—The permeable alluvium probably transmits a moderate amount of ground water past the gage site. The amount cannot be estimated.

Adequacy of record.—The record probably is a fairly adequate measure of the water yield of the basin above the gage site.

STATION 5. TRAIL CREEK AT KETCHUM

Station location.—Staff gage in the SW¼ sec. 18, T. 4 N., R. 18 E., half a mile above the mouth of Trail Creek and a quarter of a mile south of Ketchum.

Records available.—July 1920 to September 1921, when station was discontinued.

Topography.—The valley of Trail Creek opens into the Big Wood River valley, where the creek flows southwestward across the valley fill into the river. The floor of the Big Wood River valley, in the vicinity of the gage site, is slightly more than half a mile wide and is bounded on both the eastern and western sides by steep mountain slopes. A well-defined gravelly river terrace extends along the east side of the Big Wood River valley, and a gravelly terrace at a lower lever borders both sides of Trail Creek.

Geology.—Relatively impermeable Challis volcanics, through which the lower valley of Trail Creek is cut, are exposed in the east side of the Big Wood River valley. The west side is composed of well-consolidated rocks of the Wood River formation. Sediments overlying the bedrock in the vicinity of the site are rounded to subrounded pebble-, cobble-, and boulder-sized gravel interbedded with sand and silt. Similar, but less well rounded alluvial material underlies the floor of Trail Creek valley. Pebble- and cobble-sized gravels predominate.

Ground-water underflow.—The permeability of the gravel is suggested by the yield of well 4N–18E–7bd1, 6,500 feet upstream from the gage. The well reportedly yielded 825 gpm from the alluvium of Trail Creek during an aquifer test. Ground water moving out of the valley of Trail Creek spreads through the coarse alluvium in the Big Wood River valley. The amount of water that leaves the Trail Creek valley as underflow probably is moderate in amount but is believed to be an appreciable percentage of the water yield of the Trail Creek drainage area.

Adequacy of record.—The record is not an adequate measure of the water yield of the Trail Creek drainage basin, owing to ungaged ground-water underflow.

STATION 6. BIG WOOD RIVER AT GIMLET

Station location.—Staff gage in the NE¼NE¼ sec. 18, T. 3 N., R. 18 E., half a mile south of Gimlet and 6 miles south of Ketchum.

Records available.—April 1904 to May 1905, and July 1920 to September 1921, when station was discontinued.

Topography.—The Big Wood River, just above the gage site, flows south-southeastward toward the east side of its valley. About 300 feet upstream from the gage the river swings away from the east side of its valley and flows southwestward across the valley fill to the west side of the valley. The valley floor in the vicinity of the site is about three-fourths of a mile wide and is flanked on both sides by steep mountain slopes composed of consolidated rock. River terraces underlain by fluvioglacial gravel extend along both sides of the valley adjacent to the river.

Geology.—The side slopes of the valley are composed of impermeable rocks of the Wood River formation. The valley floor is underlain by sand and by cobble and boulder gravel. The gravel exposed in terraces in the vicinity of the gage site is moderately well bedded, contains rounded cobbles, and shows imbricate structure.

Ground-water underflow.—The gravel beneath the floor of the Big Wood River valley in this area is permeable and substantial in thickness. Well 3N–18E–18ac1, which is on the valley floor half a mile west of the site, reportedly yielded 900 gpm of water from the valley sediments during an aquifer test. The gage site undoubtedly is bypassed by substantial amounts of water moving through the sediments.

Adequacy of record.—The record is not an adequate measure of the water yield of the drainage area above the gage site because a substantial percentage of the water yield is ungaged ground-water underflow.

STATION 7. BIG WOOD RIVER AND BIG WOOD SLOUGH AT HAILEY (COMBINED STATIONS)

Station location.—A recording gage on the Big Wood River in the SW¼ sec. 9, T. 2 N., R. 18 E., at the highway bridge at Hailey, and another on Big Wood Slough in the SW¼ sec. 9, T. 2 N., R. 18 E., at the highway bridge at Hailey.

Drainage area.—640 sq mi (total area above river and slough stations).

Records available.—July to December 1889 (river only); June 1915 to date.

Topography.—The Big Wood River flows southward along the west side of its valley in this vicinity and is incised from 3 to 4 feet below the general level of a valley floor that is marked by shallow channel scars and gravel bars. The east and west valley slopes rise steeply from the edge of the valley floor, which is about 1¼ miles wide. River terraces underlain by gravel extend along the east side of the valley at three different levels.

Geology.—Impermeable rocks of the Wood River formation are exposed in both walls of the valley. The valley floor is underlain by fluvioglacial and alluvial gravel (fig. 13).

Ground-water underflow.—Because the gravel beneath the floor of the Big Wood River valley in the Hailey area is relatively thick and highly permeable, a large amount of water is discharged by underflow. It is believed that before the entire discharge of Indian Creek, a tributary above the gaging station, was used for the municipal water supply of Hailey, water from the creek seeped into the alluvium and was discharged by underflow. At the present time, domestic wells northeast of the gaging station obtain adequate water from the alluvium, which is saturated at shallow depth.

In 1954 the U.S. Geological Survey made an aquifer test 6 miles downvalley from station 7, using well 1N–19E–6cb1 and 2 test holes. Because geohydrologic conditions are presumed to be practically the same at station 7 as at the test site, the values obtained from the aquifer test were used to

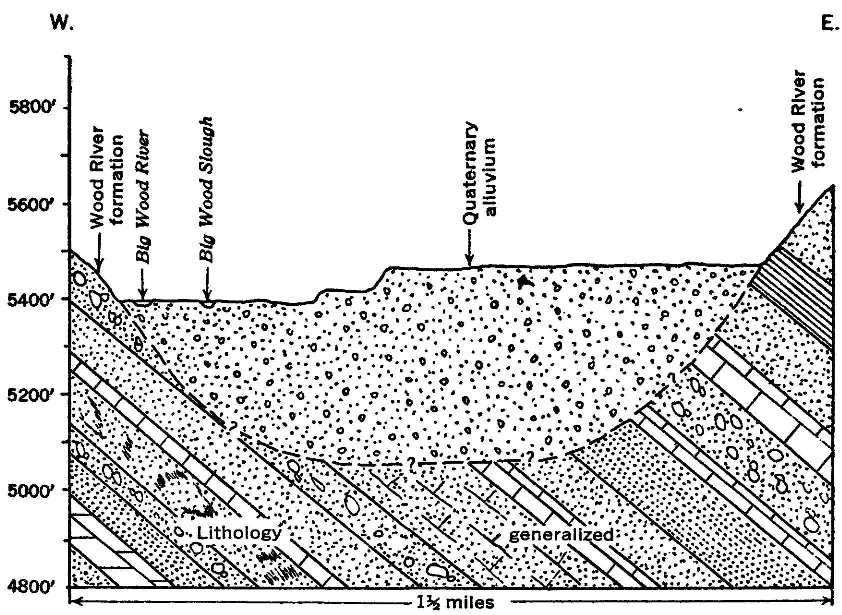

FIGURE 13.—Inferred geologic section at the site of gaging station 7, Big Wood River and Big Wood Slough at Hailey. (Datum is sea level; note vertical exaggeration.)

estimate ground-water underflow past station 7. The estimate was made by applying the formula $Q=TIW$ (see p. 19). The value of T, calculated from test data, was 1 million gallons per day per foot; the hydraulic gradient is about 34 feet per mile. The estimated average width of the aquifer in the vicinity of the gaging station is 5,250 feet. On that basis ground-water underflow through the alluvium past the station is estimated to be at least 34,500 acre-feet a year, or at least 10 percent of the average yearly yield of the basin above the station.

Adequacy of record.—The records are not an adequate measure of the water yield of the basin above the gages, owing to ungaged ground-water underflow.

STATION 8. BIG WOOD RIVER AT GLENDALE BRIDGE, NEAR BELLEVUE

Station location.—Recording gage on the line between secs. 12 and 13, T. 1 N., R. 18 E., at Glendale bridge, 2½ miles southwest of Bellevue.

Records available.—May 1920 to August 1921, when station was discontinued.

Topography.—Above the gage site the valley is about 2 miles wide; it is bounded on the east by mountains having high relief and on the west by mountains having moderate relief. Two terraces underlain by gravel extend along the east side of the valley. Immediately below the gage site the valley widens abruptly to the west forming a conspicuous lobe, known as Poverty flat (pl. 2). The flood plain generally averages three-fourths of a mile in width, but at the gage site it is constricted between a spur of the terraces on the east and bedrock on the west.

Geology.—A small body of Challis volcanics crops out an eighth of a mile northwest of the site, forming the point of the bedrock spur. Consolidated rocks crop out in the channel of the river immediately above the gage site and about two-thirds of a mile upstream. The east valley wall consists of consolidated sedimentary rocks. A bed of massive tuffaceous clayey sediment crops out on the slope of the river terrace a short distance northeast of the site. Coarse gravel and sand underlie the valley floor. Conditions similar to those around the station are illustrated in figure 14.

Ground-water withdrawals.—Seven wells between stations 7 and 8 have a combined yield of about 10,300 gpm (Smith, 1959). The wells are pumped only during the irrigation season, from July to September. The effect of that pumping on return flow to the Big Wood River is problematic. Much of the water pumped by the wells is outside the area naturally tributary to the Big Wood River and is on its way to the Silver Creek area (pl. 2).

Ground-water underflow.—The gage site is bypassed by a large amount of water moving downvalley through the permeable valley fill. Substantial amounts of surface water discharged by Quigley, Slaughterhouse, and Seamans Creeks, eastern tributaries of the Big Wood River, and much irrigation water that is diverted from the Big Wood above the gage site, sink into the gravel of the valley floor upvalley from the gage site. Well 1N–19E–6cb1, which is on an intermediate terrace level 1⅔ miles northeast of the site, yields 1,200 gpm. Water from Quigley, Slaughterhouse, and Seamans Creeks does not reach the Big Wood at the surface, but sinks into the alluvium along the east side of the valley north of the site. From there much, if not all, of the water moves by underflow to the Silver Creek drainage area. A large part of the water that is lost by seepage from the channel of the Big Wood River above the gage site, joins the ground water in the valley alluvium northeast of the site. During the irrigation seasons of 1920 and 1921 the water lost by seepage averaged 29.2 cfs in a 7-mile reach of the river (Chapman, 1921). That ground water does not return to the river, but,

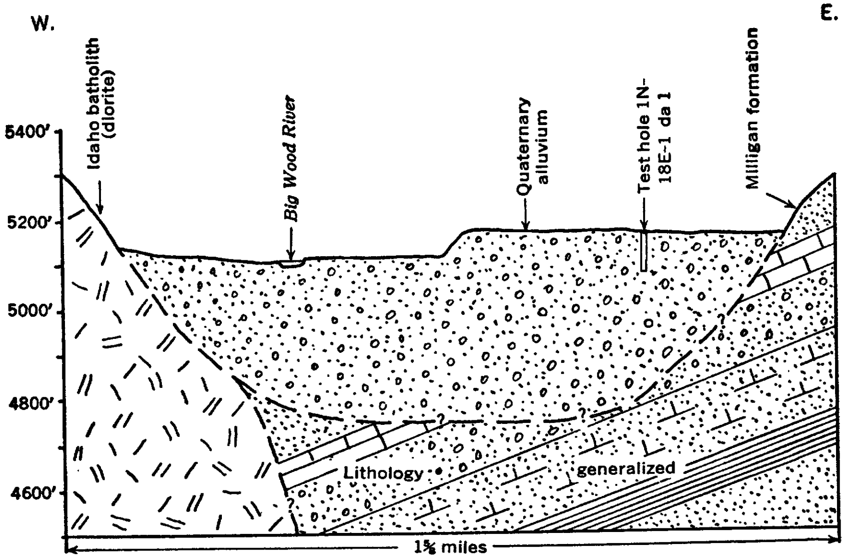

FIGURE 14.—Inferred geologic section at the site of test hole 1N–18E–1da1, 1⅝ miles northeast of station 8, Big Wood River at Glendale bridge, near Bellevue. (Datum is sea level; note vertical exaggeration.)

being east of the ground-water divide (pl. 2), it moves into the Silver Creek drainage basin. The bedrock that crops out in the channel of the river just upstream from the site possibly slopes eastward at a relatively shallow depth beneath the valley floor. If so, this bedrock may cause ground water to be diverted southeastward.

Data from the aquifer test at well 1N–19E–6cb1, about 1½ miles upvalley from the gage site, were used to estimate ground-water underflow at this site. The recorded surface-water flow for a 150-day irrigation period in 1920 (a year of less-than-average runoff) was used as a basis to compute the percentage of ground-water underflow. During that period 77,400 acre-feet of surface water passed the gage. It is estimated that unmeasured underflow past the site is 14,500 acre-feet during a 150-day period, or at least 15 percent of the water yield of the basin above the gage site. The estimate, of course, is only approximate because it is based on a short period in a year of deficient runoff. The percentage of underflow varies with the seasons and with the stage of the river.

Adequacy of record.—The record is not an adequate measure of the water yield of the basin above this former gaging station because of unmeasured underflow along the main-stem drainage, and migrant underflow east of the ground-water divide.

STATION 9. BIG WOOD RIVER NEAR BELLEVUE

Station location.—Recording gage in sec. 20, T. 1 S., R. 18 E., 1¾ miles upstream from the flow line of Magic Reservoir, and 10 miles southwest of Bellevue. The station was moved about half a mile upstream in the fall of 1954.

Drainage area.—823 sq mi.

Records available.—July 1911 to date (except winter of 1942 and winters of all years prior to 1940).

Topography.—The river flows westward in this vicinity and meanders in a braided channel across a valley floor that is about 2,000 feet wide and is bounded on the north by a range of low rounded hills, and on the south by a nearly vertical cliff that rises about 60 feet above the valley bottom. The valley bottom is nearly flat except for shallow channel scars and low sand and gravel bars. There are no river terraces in this vicinity.

Geology.—Snake River basalt forms the cliff at the south side of the valley (fig. 15). The hills along the north side consist of granitic rocks which crop out also at the foot of the southern basalt cliff. The valley floor is underlain by an undetermined thickness of interbedded silt, sand, and coarse gravel. The river channel contains beds of clay in some places.

Ground-water withdrawals.—Flowing artesian wells with a combined yield of about 13,200 gpm have been developed since the fall of 1948 in a small area above this station. The wells are used only during the irrigation season and most of the water that is not consumptively used returns to the Big Wood River above the station by surface runoff and ground-water discharge.

Ground-water underflow.—Large losses of water occur by seepage from the channel of the Big Wood River and from irrigation canals above the gage, just below station 8. Part of the seepage water becomes ground-water return flow to the river above the gage, but a large part reaches the water table east of a ground-water divide and moves into the Silver Creek basin. Due to the narrow width of the valley and to the evident shallowness and rather low permeability of the alluvium in the vicinity of the gage, however, ground-water underflow past the gage probably is only 1 or 2 percent of the total volume of water moving past the gage.

Adequacy of record.—The record is an adequate measure of the total volume of water moving past this station and hence is entirely adequate as a record of the Big Wood River water that reaches Magic Reservoir. However, as noted in the discussion of station 8, a large amount of water leaves the Big Wood main-stem drainage and migrates underground to the Silver Creek drainage. Station 24 does not provide an adequate record of the water yield of the Silver Creek basin. Therefore, the combined records from stations 9 and 24 are not an adequate measure of the water yield of the upper Big Wood River main-stem basin.

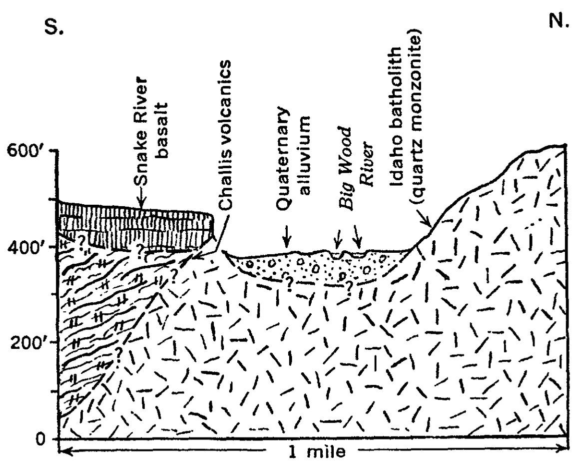

FIGURE 15.—Inferred geologic section at the site of gaging station 9, Big Wood River, near Bellevue. (Datum is arbitrary; note vertical exaggeration.)

STATION 10. CAMAS CREEK NEAR BLAINE

Station location.—Recording gage in sec. 15, T. 1 S., R. 16 E., three-eighths of a mile downstream from the mouth of Willow Creek, 2¼ miles upstream from the backwater of Magic Reservoir, and 4 miles southeast of Blaine.

Drainage area.—618 sq mi.

Records available.—May 1912 to date (no winter records prior to 1945); discharge measurements without gage record for 1922.

Topography.—Camas Creek, in this vicinity, flows eastward through a narrow gorge eroded about 50 feet deep in Snake River basalt. The floor of the gorge is only a few feet wider than the stream channel. The stream is bounded on both sides by steep talus slopes and in places by narrow sand bars.

The gently rolling surface formed by the basalt ends just north of the station, where the basalt is overlain by alluvial material that forms low rounded hills. Four miles south of the station the scarp of the Mount Bennett Hills rises steeply from the edge of the basalt.

Geology.—The vesicular basalt which forms the walls of the gorge consists of several distinct flow layers, each of which has characteristic columnar jointing. The floor of the gorge is underlain by an undetermined but probably negligible thickness of coarse sand, gravel, and basalt blocks (fig. 16). The Snake River basalt in the vicinity of the station is a tongue of the large flows that originated on the plain and invaded the mouth of Camas Creek valley.

Ground-water withdrawals.—An undetermined but substantial amount of ground water is withdrawn from wells for domestic use and irrigation in Camas Prairie. The water from several springs also is utilized for irrigation, bathing, and domestic use. Part of the unconsumed ground water from the basin reaches Camas Creek as ground-water underflow; the remainder probably leaves the basin as underflow into the basalt of the Snake River Plain.

Ground-water underflow.—Permeable sand and gravel probably are interbedded with the basalt flows beneath station 10. Ground water in interflow aquifers

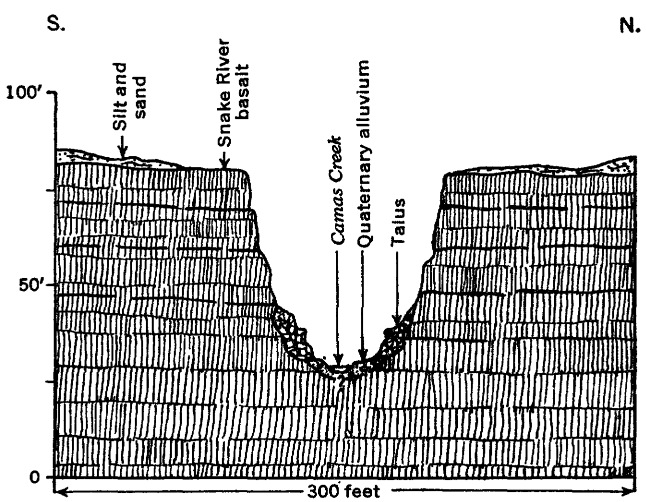

FIGURE 16.—Inferred geologic section at the site of gaging station 10, Camas Creek, near Blaine. (Datum is arbitrary; note vertical exaggeration.)

that communicate with the alluvium of the Camas Creek basin upstream from the station would leave the basin by underflow. An appreciable amount of surface water probably enters voids along flow contacts, open joints, and other types of openings in the basalt along the gorge above the station, especially during high-water stages, and that water passes unmeasured beneath the gage. The amount of water from Camas Prairie that enters the basalt above the station and leaves the valley by underflow is not known and cannot be estimated at present. Some of the escaping water may reach Magic Reservoir and some may pass into the main body of ground water in the Snake River basalt in the Richfield district.

Adequacy of record.—The record is not an entirely adequate measure of the water yield of the Camas Creek basin.

STATION 11. BIG WOOD RIVER BELOW MAGIC DAM, NEAR RICHFIELD

Station location.—Recording gage in sec. 8, T. 2 S., R. 18 E., half a mile downstream from Magic Dam and 18 miles northwest of Richfield.

Records available.—April 1911 to date.

Topography.—The river flows south-southeastward through a narrow gorge that is about 150 feet deep and has nearly vertical walls. At some places basalt talus covers the lower parts of the walls. The valley floor is about 200 feet wide at the station. Narrow discontinuous gravel terraces 4 to 6 feet high extend along both sides of the river. The Picabo Hills rise steeply from the edge of the basalt a short distance east of the gorge.

Geology.—The walls of the river gorge are composed of horizontal layers of dense to vesicular basalt with columnar jointing. The floor of the gorge is underlain by sandy silt and lenses of coarse gravel, and the channel contains many local bars of coarse gravel (fig. 17).

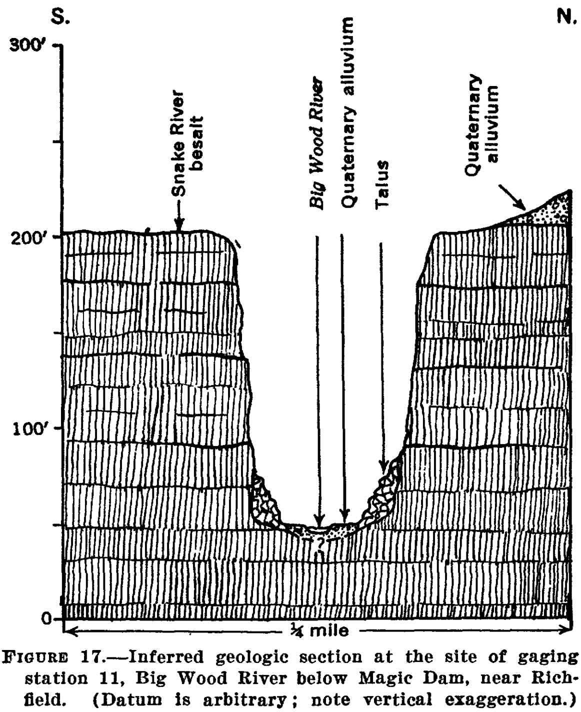

FIGURE 17.—Inferred geologic section at the site of gaging station 11, Big Wood River below Magic Dam, near Richfield. (Datum is arbitrary; note vertical exaggeration.)

Ground-water underflow.—The river loses a considerable amount of water between stations 11 and 27 (Big Wood River near Gooding), but the short reach of river channel between Magic Reservoir and station 11 is insulated with silt and sand. Channel loss above the gage probably is small.

Adequacy of record.—The record represents adequately the discharge from Magic Reservoir, but is not an accurate measure of the water yield of the upper Big Wood River Basin. The records from this station, and successive downstream stations, however, are a source of valuable data for studies of channel losses during the periods of runoff past the downstream stations.

STATION 12. BIG WOOD RIVER ABOVE NORTH GOODING CANAL, NEAR SHOSHONE

Station location.—Staff gage in sec. 10, T. 4 S., R. 18 E., 1 mile upstream from the North Gooding Canal, 13 miles downstream from Magic Dam, and 14 miles northeast of Shoshone.

Records available.—April 1921 to February 1939, when station was discontinued. No water was discharged past this gage in the water years 1926, 1928–31, and 1934–37.

Topography.—The river channel follows the west edge of a Recent basalt flow (Shoshone lava field) at the bottom of a deep, narrow gorge in the underlying Snake River basalt. The gorge trends south-southwest and has an uneven floor which is veneered with alluvium. Adjacent to the gorge on the west the Snake River basalt has a gently rolling surface, much of which is mantled by windblown silt. On the east the rough surface of the fresh, broken Recent basalt flow stands a few feet higher than that of the older basalt.

Geology.—Layers of Snake River basalt are exposed in the walls of the gorge (fig. 18), where the rock has dense to vesicular texture and columnar jointing. The east rim of the gorge is formed by the highly fractured vesicular Recent basalt. Thin sheets of sand and gravel occur on some of the rock terraces in the gorge, but the river bed contains only isolated small deposits of alluvium.

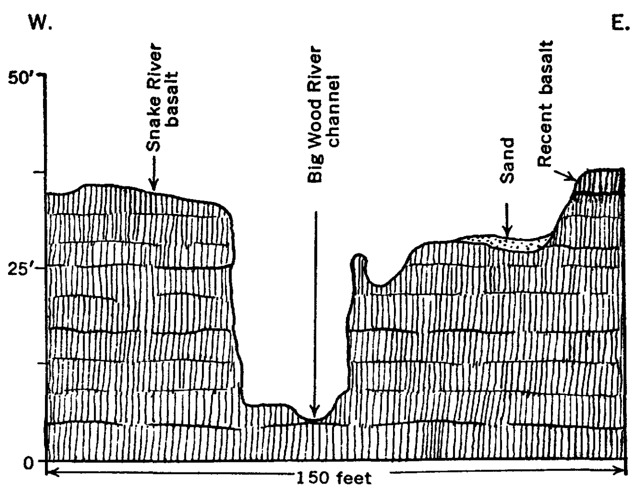

FIGURE 18.—Inferred geologic section at the site of gaging station 12, Big Wood River above North Gooding Canal, near Shoshone. (Datum is arbitrary; note vertical exaggeration.)

Ground-water underflow.—Numerous open joints in the basalt in the river bed, voids along the contacts between flows exposed in the sides of the channel, and miscellaneous openings in the basalt over which the river flows, all would permit substantial loss of river water, which would percolate downward to the deep zone of saturation in the Snake River basalt. Since 1925, however, all of the river water has been diverted through the Lincoln Canal, and the river channel is dry except during periods of flood runoff. Before the canal was put in use the channel loss in the reach between station 11, just below Magic Reservoir, and station 13, just below the head of the North Gooding Canal, averaged 113.4 cfs during an 8-year period.

Adequacy of record.—The record represents the surface flow past the station during the period of record but does not represent the water yield of the basin.

STATION 13. BIG WOOD RIVER BELOW NORTH GOODING CANAL, NEAR SHOSHONE

Station location.—Staff gage in sec. 15, T. 4 S., R. 18 E., a quarter of a mile downstream from the North Gooding Canal, 11 miles northeast of Shoshone, and 14 miles downstream from Magic Dam.

Records available.—January 1911 to February 1939, when station was discontinued. There was no water discharged past this gage in the water years 1929, 1931, and 1934–37.

Topography.—The topography around the station site is practically identical with that at station 12, except that a group of sand dunes overlies the Snake River basalt between the site and a shallow surface bypass channel on the east.

Geology.—The geology is almost identical with that at station 12. Here, however, the Recent basalt borders the surface bypass channel on the east. The bed of the bypass channel contains outcrops of Snake River basalt overlain by isolated deposits of alluvium.

Ground-water underflow.—The general conditions are the same as at station 12, and would permit comparable losses of water. Previous to the diversion of water from the Big Wood River through the North Gooding Canal in 1916, large losses may have occurred by seepage from the bed of the bypass channel during periods of high water. Since 1916, however, most of the river water has been diverted above the gage through the Lincoln Canal and the North Gooding Canal. The river channel is dry except during periods of flood runoff and at times when spillage from the two canals is returned to the river above the gage site.

Adequacy of record.—The records represent the surface flow past the station during the period of record but do not represent the water yield of the basin.

STATION 14. BIG WOOD RIVER NEAR SHOSHONE

Station location.—Staff gage in sec. 17, T. 5 S., R. 17 E., at the A. D. Silva ranch, 1 mile downstream from the steel wagon bridge and 7 miles northwest of Shoshone; 24 miles below Magic Dam.

Records available.—June 1905 to August 1913, when station was discontinued.

Topography.—The river channel trends westward near the northern edge of the Recent basalt for some miles above and below the gage site. At the site the river swings away from the Recent basalt and winds through a narrow flood plain on the floor of a narrow shallow valley. The channel is incised 8 to 10 feet below the general level of the flood plain and locally contains bars of coarse gravel. The Snake River basalt crops out at many places in the river channel and flood plain; elsewhere it is covered by only a few feet of sediment. Downstream from the gage site the river channel crosses so-called pressure ridges in the basalt. These ridges form the north border of the flood plain. The flood plain is bordered on the south by Recent basalt.

Geology.—Snake River basalt crops out in the river channel, along the northern edge of the flood plain, and on the plain to the north. Recent basalt occupies the southern rim of the valley and the plain to the south. The exposed flood-plain material is sandy silt. Sand and gravel bars occur in the river channel and undoubtedly similar materials occur beneath the flood plain.

Ground-water underflow.—The apparent average channel loss was substantial in this reach during the period of record. The loss, however, was not as great as in the reach between stations 11 and 13, probably because the river channel in this reach is partly insulated with sandy silt, which seems to inhibit seepage loss into the Snake River basalt. (See discussion of channel losses in Richfield district, p. 27–28, and in Gooding district, p. 29.)

Adequacy of record.—The record represents the surface flow past the station during the period of record but does not represent the water yield of the basin.

STATION 15. BIG WOOD RIVER ABOVE THORN CREEK, NEAR GOODING

Station location.—Recording gage in the NW¼ sec. 7, T. 5 S., R. 16 E., at the Manuel Silva ranch, a quarter of a mile above Thorn Creek and 8½ miles northeast of Gooding.

Records available.—April 1926 to May 1927, when station was discontinued.

Topogruphy.—The river is bounded on the north by the gently rolling silt-mantled surface of the Snake River basalt, and on the south its narrow flood plain terminates against Recent basalt. The river occupies a shallow gorge that trends westward, with an average depth of 10 feet and a width of about 100 feet. Narrow banks of alluvium extend along both sides of the channel, which contains sand and gravel bars alternating with basalt outcrops.

Geology.—Snake River basalt crops out in the river bed and along both banks, and is overlain by Recent basalt along the southern edge of the flood plain. The flood plain and river banks consist of very sandy silt.

Ground-water underflow.—As at gage site 14, the apparent average channel loss was substantial in this reach during the period of record, but here also the channel is partly insulated with sandy silt, which inhibits channel losses when there is water in the river. (See discussion of channel losses in Richfield district, p. 27–28, and in Gooding district, p. 29.)

Adequacy of record.—The record represents the surface flow past the station during the period of record, but does not represent the water yield of the basin.

STATION 16. BIG WOOD (MALAD) RIVER AT GOODING (TOPONIS)

Station location.—Recording gage in the NE¼NE¼ sec. 31, T. 5 S., R. 15 E., 30 feet downstream from the highway bridge and half a mile north of Gooding.

Records available.—June 1896 to October 1899 (published as Malade River at Toponis), April 1921 to September 1948, except for winter periods. Records since 1948 collected and published by watermaster for Big Wood River basin, at Shoshone, Idaho (Jones, 1952, p. 8).

Topography.—The river flows westward through a narrow flood plain that is bounded on the north and south sides by the gently rolling surface of the

Snake River Plain. A rock terrace about 40 feet high parallels the river an eighth of a mile south of the station.

Geology.—Snake River basalt crops out along the northern edge of the flood plain and in the river channel, and forms the rock terrace south of the station site. The flood plain is underlain by unconsolidated sand and silt. The river bed, except for several basalt outcrops upstream from the site, is lined with sand and well-rounded gravel.

Ground-water underflow.—An appreciable amount of river water percolates into the Snake River basalt in this reach. The channel, however, is partly insulated by sand and silt which probably inhibits infiltration. (See discussion of channel losses in Richfield district, p. 27–28, and in Gooding district, p. 29.)

Imported recharge.—Canals carrying water from both the Snake and Big Wood Rivers parallel the river on both sides and deliver irrigation water to the flood plain. The watermaster reports that the river gains water in the reach that includes the station site. Part of the gain is derived from imported Snake River water which reaches the channel above the gage site by underflow of perched ground water through flood-plain alluvium.

Adequacy of record.—The record represents the surface flow past the gage during the periods of record, but doesn't represent the water yield of the basin. The record, however, would be of special interest and importance in studies of channel losses and gains.

STATION 17. DRY CREEK NEAR BLANCHE

Station location.—Staff gage in sec. 5, T. 4 S., R. 14 E., about 250 feet below the site of a former diversion dam, two-thirds of a mile upstream from the Crist ranch, about 10 miles from Blanche post office, and about 16 miles northeast of Bliss.

Records available.—September 1911 to April 1914, when station was discontinued. Records incomplete.

Topography.—Dry Creek occupies a deep narrow gorge in the south slope of the Mount Bennett Hills. In the vicinity of the gage site the stream flows

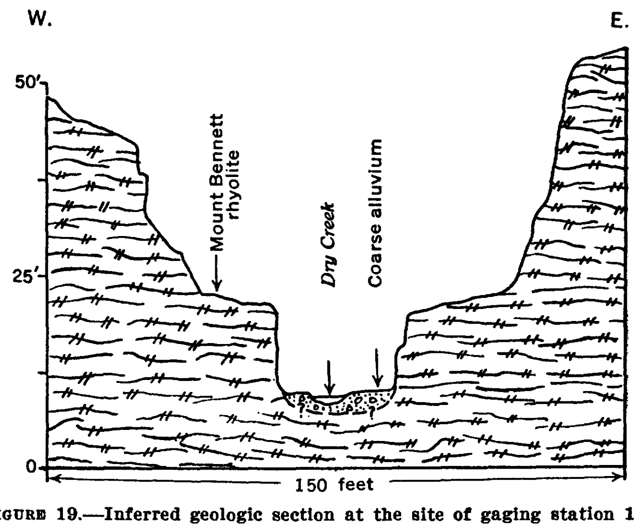

FIGURE 19.—Inferred geologic section at the site of gaging station 17, Dry Creek, near Blanche. (Datum is arbitrary; note vertical exaggeration.)

southwestward in a gorge about 50 feet deep and 30 feet wide at the bottom. The gorge increases in width and depth by a series of rock terraces (fig. 19).

Geology.—The walls of the gorge are formed by a sequence of rhyolite-flow rocks that dip, in general, uniformly southward. Weathering of the rhyolite produces flat slabs. The floor of the gorge is underlain by a few feet of silt, sand, and angular to subrounded fragments of basalt and rhyolite.

Ground-water underflow.—The amount of ground-water underflow through the alluvium in the bottom of the gorge and through the fractures and joints in the rhyolite probably is negligible.

Adequacy of record.—The record is an adequate measure of the water yield of the Dry Creek drainage area above the gage.

STATION 18. MULDOON CREEK NEAR MULDOON

Station location.—Staff gage in the SE¼ sec. 15, T. 2 N., R. 20 E., an eighth of a mile above the mouth of Muldoon Creek, 9 miles southwest of Muldoon post office, and 14 miles northwest of Carey.

Records available.—June to August 1925, when station was discontinued.

Topography.—In the vicinity of the gage site Muldoon Creek flows westward through a gorge eroded in lava flows that entered and partly filled an older valley. The average depth of the gorge is about 50 feet and the average width is about 350 feet. The walls are nearly vertical. Low gravel terraces extend along both sides of the floor of the gorge. The sides of the older valley rise steeply from the rolling surface of the basalt fill.

Geology.—Successive basalt flows of Quaternary age, which have an average thickness of about 6 feet and in which columnar jointing is well developed, are exposed in the walls of the gorge. The floor of the gorge is underlain by an undetermined thickness of interbedded silt, sand, and poorly sorted gravel. Stream terraces in the gorge are underlain largely by coarse alluvial gravel ranging in size from sand to boulders. Basalt blocks form talus slopes that extend to the edge of the stream in places. The basalt flows probably overlie alluvium that partly filled an ancestral valley.

Ground-water underflow.—The alluvium exposed in stream banks near the gage site contains a high proportion of silt, which partly insulates the stream channel. There is no observed geologic evidence of appreciable ground-water underflow past the gage. Water may enter the basalt flows and underlying alluvium about 3 miles upstream, however, and pass the gage site by underflow through the basalt and alluvium which fill the valley in this reach.

Adequacy of record.—The record probably is an adequate measure of the water yield of the Muldoon Creek basin.

STATION 19. LITTLE WOOD RIVER AT CAMPBELL RANCH, NEAR CAREY

Station location.—Recording gage in the SW¼NW¼ sec. 35, T. 2 N., R. 20 E., at Campbell Ranch, above the flow line of Little Wood Reservoir, 1½ miles downstream from High Five Creek, 2½ miles downstream from the mouth of Muldoon Creek, 11 miles east of Bellevue, and 12 miles northwest of Carey.

Drainage area.—267 sq mi.

Records available.—February 1920 to September 1926 (published under the station name "Little Wood River near Carey"); March 1941 to December 1942; April 1944 to date. No winter records except 1921–24, 1926.

Topography.—The canyon of the Little Wood River at, and just above, the gaging station is incised along the west edge of a sequence of basalt flows.

The flows are about three fourths of a mile wide but of unknown thickness; they occupy a larger ancestral valley of the river. The east side of the canyon is a nearly vertical basalt wall about 200 feet in height, and the west side is formed by the steep slope of the ancestral valley. The floor of the canyon is about 1,200 feet wide at the station. The ancestral valley walls rise steeply from the basalt fill to upland topography having high relief.

Geology.—The sides of the ancestral valley are formed by Challis volcanics. The basalt of Quaternary age that fills the valley is composed of nearly horizontal flow layers in which there is columnar jointing. A series of the flows is exposed in the east wall of the gorge, where the texture of the individual flows ranges from dense, near the bottom, to vesicular at the top. Drill hole 1N–20E–12cc1, 2½ miles downstream from the gage, was drilled through 35.2 feet of water-bearing alluvium beneath the flows. The floor of the canyon is underlain by an unknown thickness of silt and coarse gravel. Hand-auger holes, which were sunk in the valley floor across the river from the station, show 0.5 to 6.7 feet of coarse sand and sandy silt overlying wet gravel. Gravel is exposed in the banks of the river.

Ground-water underflow.—Geologic evidence indicates that a moderate amount of ground water probably passes by underflow through the permeable alluvium beneath the valley floor in the vicinity of the gaging station. Water from a spring in the west valley slope sinks into the alluvium on the valley floor; there is no surface flow from the spring beyond a point about 500 feet southwest of the gaging station. The amount of subsurface water that also passes downvalley through the joints and flow contacts of the basalt valley fill and underlying alluvium is not known. Ground-water underflow probably is an appreciable percentage of the water yield.

Adequacy of record.—The record is a fairly adequate measure of the water yield of the basin, except for an unknown and possibly appreciable amount of water that moves through permeable basalt and underlying alluvium in the main valley of the Little Wood River.

STATION 20. LITTLE WOOD RIVER NEAR CAREY

Station location.—Recording gage in the E½ sec. 30, T. 1 N., R. 21 E., a third of a mile upstream from East Canal, 2 miles downstream from the mouth of Little Fish Creek, 3 miles downstream from the Little Wood Reservoir, and 6 miles northwest of Carey.

Drainage area.—312 sq mi.

Records available.—April 1904 to May 1905; September 1926 to date.

Topography.—The river valley consists of a younger inner valley eroded in alluvium and basalt, which partly fills an older, larger valley which is bounded on both sides by steep mountain slopes (fig. 20). The width of the valley across the gently rolling surface of the basalt and gravel is about half a mile.

A short distance above the gaging station the river flows southward between basalt flows and the east side of the older valley, then it swings westward into the basalt area and flows through a gorge to the station. The gorge is about 30 feet deep, 45 feet wide, and 1,000 feet in length. The walls are almost vertical.

Geology.—The ancestral (older) valley was cut in Challis volcanics which dip generally eastward and are exposed in the valley slopes above the levels of the basalt and alluvium. The basalt flows are nearly horizontal. Broad low alluvial fans and other river gravel cover the basalt along most of the

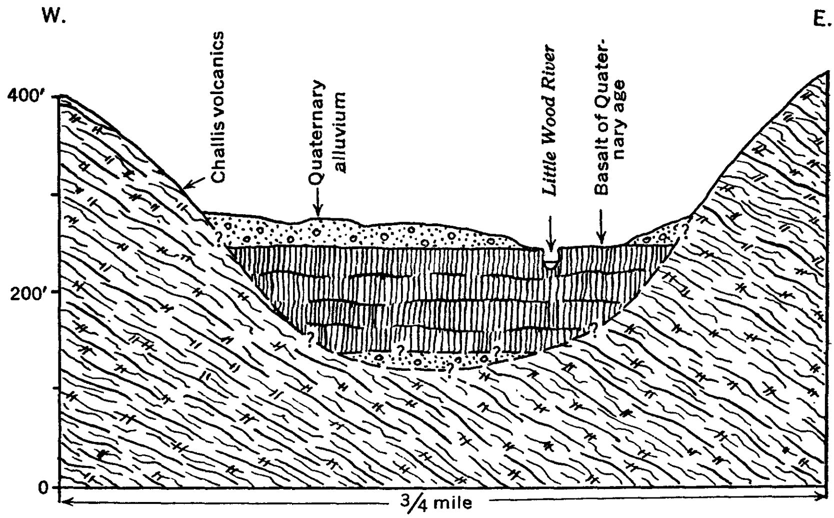

FIGURE 20.—Inferred geologic section at the site of gaging station 20, Little Wood River, near Carey. (Datum is arbitrary; note vertical exaggeration.)

reach in the vicinity of the gage. The river gorge is cut in jointed vesicular basalt of Quaternary age. The river channel is lined with silt, sand, well-rounded gravel, and angular blocks of basalt. Test hole 1N–20E–12cc1, 3½ miles upstream from the station, was drilled into old alluvial fill beneath the basalt flows. Very likely the alluvium is present beneath the basalt in the vicinity of the gage.

Ground-water underflow.—The amount of underflow through the basalt past the station is not known but may be appreciable, depending on whether there are unusually permeable zones in the basalt. Where the basalt is exposed it is not very permeable. The underlying Challis volcanics are only slightly permeable. Some underflow through the permeable gravel that underlies the basalt in the valley enters the Snake River basalt in the Richfield district downstream from the station. Well 1S–21E–16cd2 yields 1,800 gpm of water from the alluvium downvalley from the basalt (table 2). The estimated amount of ungaged underflow is about 5 to 10 percent of the total yield.

Adequacy of record.—The record is a fairly adequate measure of the water yield from the upper Little Wood River drainage area.

STATION 21. FISH CREEK ABOVE DAM, NEAR CAREY

Station location.—Recording gage and Cipolletti weir, in sec. 2, T. 1 N., R. 22 E., 1¼ miles upstream from the West Fork of Fish Creek, 1½ miles upstream from the dam of the Carey Valley Irrigation Co., and 14 miles northeast of Carey.

Drainage area.—About 56 sq mi.

Records available.—May 1920 to September 1939, when station was discontinued. Records for irrigation seasons only, except 1921, 1922, 1926, and 1927.

Topography.—The valley floor in the vicinity of the gage site is about two-thirds of a mile wide and is bounded on both sides by mountains of high relief. Broad alluvial fans from the mountain sides encroach on the valley floor. The main stream channel and shallow, meandering cutoff channels lead southward on the flat valley floor and reach Fish Creek Reservoir just below the site.

Geology.—Both sides of the valley are formed by well-consolidated sedimentary rocks of Carboniferous age. The valley floor is underlain by alluvium, the thickness of which is unknown. Hand-auger holes near the gage site show one-half to 2 feet of silty clay overlying coarse sand and fine gravel. The silty clay is exposed in the banks of the stream and at places the sand and gravel crop out beneath it.

Ground-water underflow.—Ground-water underflow past the gage site through the sand and gravel is at least moderate. The hand-auger holes filled with water approximately to the level of the water surface of the stream when the sand and gravel bed was tapped. Shallow abandoned stream channels west of the site contain ponded water. Irrigation water that is diverted upstream from the gage site sinks beneath the valley floor east of the site.

Adequacy of record.—The record probably is an adequate measure of the water yield of the upper Fish Creek basin, although the ground-water underflow cannot be estimated at present.

STATION 22. WEST FORK OF FISH CREEK, NEAR CAREY

Station location.—Staff gage, in sec. 3, T. 1 N., R. 22 E., 1¾ miles above the confluence with Fish Creek and 14 miles northeast of Carey.

Drainage area.—About 12½ sq mi.

Records available.—May 1920 to September 1929, when station was discontinued. Direct measurements of discharge were made only in 1923.

Topography.—The stream meanders on a valley floor that trends southward and is about 800 feet wide at the gage site. The valley heads in high, rugged mountains to the north and is bounded on both sides by steep mountain slopes. Two prominent alluvial fans encroach on the floor from the mouths of tributary stream valleys east and west of the site. The stream is incised about 6 feet below the general level of the valley floor in the vicinity of the site.

Geology.—Both sides of the valley are formed by well-consolidated sedimentary rocks. Quartzite and quartzitic breccia of Carboniferous age crop out in the sides of the valley near the gage site. Hand-auger holes in the valley floor disclosed about 6½ feet of silt and sandy clay overlying coarse sand and fine gravel. The thickness of the gravel is not known. The alluvial fans are composed of silt and coarse, angular rock fragments.

Ground-water underflow.—The sand and fine gravel beneath the valley floor are saturated with water as indicated by the water that entered the auger holes when the permeable alluvium was drilled into. However, ground-water underflow past the station site through the alluvium probably is negligible because the cross-sectional area of the alluvium undoubtedly is small.

Adequacy of record.—The record probably is an adequate measure of the water yield of the basin drained by the West Fork of Fish Creek.

STATION 23. FISH CREEK NEAR CAREY

Station location.—Recording gage in sec. 15, T. 1 N., R. 22 E., 600 feet downstream from the Carey Valley Irrigation Co. dam.

Records available.—April 1919 to September 1920; May 1923 to September 1939, when station was discontinued. Irrigation seasons only, 1924–29, 1931–33, 1939. Direct measurements of discharge in 1921 and 1922 only.

Topography.—Both sides of the valley rise steeply to somewhat rounded mountainous terrain in which there are a few rugged areas. The rolling surface of the valley floor, having an average width of about two-thirds of a mile, is formed by basalt flows. A transverse ridge of basalt, which seems to mark the eruptive source of the local lava flows, extends across the middle of the valley just above the station. The surface of the basalt flows slopes away from the axis of the ridge both upvalley and downvalley. The western nose of the ridge slopes downward to a deep, narrow gorge through which Fish Creek flows. The Carey Valley Irrigation Co. dam, a concrete structure 105 feet high, 1,800 feet long at the top, and only 40 feet long at the bottom, occupies part of the sloping western nose of the basalt ridge and the gorge of Fish Creek.

The Fish Creek gorge along the west side of the basalt is about 40 feet deep, having a floor and eastern wall of basalt and a west wall of Carboniferous rocks. The gorge widens from the constricted throat occupied by the dam to about 800 feet at the gaging station site, but becomes constricted again about 1,200 feet below the gage site. The floor of the gorge is an uneven surface marked by abandoned channel scars and low gravel bars.

Geology.—Well-consolidated Carboniferous rocks crop out on both sides of the valley (fig. 21) and at the foot of the east wall of the gorge near the Carey Valley Irrigation Co. dam. The basalt of Quaternary age that partly fills the valley consists of nearly horizontal layers of dense-to-vesicular basalt with columnar jointing. The basalt is exposed in the floor of Fish Creek Reservoir and in the walls of the river gorge. The lava flows seemingly originated just above and east of the gaging-station site and extend from the center of the Fish Creek Reservoir down the valley onto the basalt of the Snake River Plain. Hand-auger holes in the floor of the river gorge disclosed 3 to 4.5 feet of silt and clay overlying coarse gravel. A low stream terrace, which extends along the east side of the gorge floor, consists of coarse, moderately well rounded gravel. The west end of the dam abuts the consolidated Carboniferous rocks; the east end and most of the base rest on permeable basalt.

Ground-water underflow.—Geologic evidence indicates that a large amount of ground water bypasses the gage site through the permeable alluvium beneath the floor of the gorge and through the permeable basalt in the valley. An appreciable amount of ground-water underflow may occur through old alluvial valley fill that probably underlies the basalt. The gage was on an artificial stream channel which was dredged for about 1,000 feet downstream

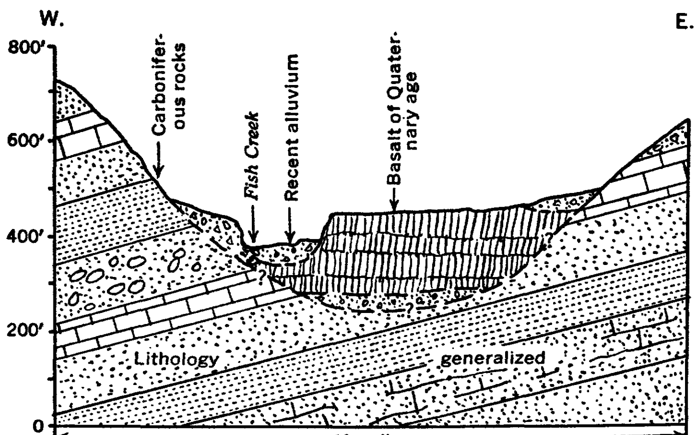

Figure 21.—Inferred geologic section at the site of gaging station 23, Fish Creek, near Carey. (Datum is arbitrary; note vertical exaggeration.)

from the dam. The natural channel, which bypasses the site and leads to a swamp downstream, is underlain by gravel which is an efficient conduit for ground-water underflow. Ground water was struck in this gravel in auger holes that were sunk in the floor of the gorge. Springs issue from the basalt at intervals along the walls of the gorge in a reach extending from the dam downstream to about 1,000 feet below the gage site. The caretaker of the dam reports that the springs did not exist before the dam was built. The caretaker and the watermaster both report that since the dam was built whirlpool motions have been observed in the water above numerous holes and crevices in the basalt floor of Fish Creek Reservoir, indicating loss of water into the holes. They report also the presence of a substantial new spring discharging from the valley basalt into Fish Creek about 1½ miles below the dam. The spring reportedly is intermittent and begins to discharge water about 30 days after the reservoir has been filled to three-fourths capacity. Part of the ungaged underflow in this area moves down-valley through the valley basalt and enters the Snake River basalt in the Richfield district. The watermaster reports that after the dam was completed, new springs appeared in the downstream end of the basalt flow, near the mouth of the Fish Creek valley. The observed behavior of ground water and surface water, general knowledge about the geohydrology in the vicinity of the gage and reservoir, and historic changes noted by water users, all indicate that conditions are suitable in the vicinity of station 23 for a substantial amount of water to pass beneath or around the gage by underflow. Ungaged underflow is estimated to be between 10 and 15 percent of the water yield.

Adequacy of record.—The record is not an adequate measure of the water yield of the Fish Creek basin because underflow through the valley basalt from the dam to the Snake River Plain is substantial.

STATION 24. SILVER CREEK NEAR PICABO

Station location.—Recording gage in sec. 1, T. 2 S., R. 20 E., 1½ miles downstream from drainage ditch of Blaine County Drainage District No. 1, and 3 miles southeast of Picabo.

Records available.—May 1920 to date. Records of 1922–35 for irrigation seasons only.

Topography.—The gaging station is on the rolling surface of a tongue of Snake River basalt which blocks the mouth of an older gap that was cut through Challis volcanics at the eastern end of the Picabo Hills. The basalt tongue is bounded on the east by a spur of the Pioneer Mountains and on the west by the eastern end of the Picabo Hills. Upstream from the basalt area Silver Creek flows southeastward through alluvium along the southwest foot of the Pioneer Mountains. Through the basalt the stream course is south-southeastward and its immediate valley is cut about 5 feet below the general level of the surrounding basalt. The stream flows in several channels on a narrow flood plain.

Geology.—The Picabo Hills and the mountain spur east of the station are composed largely of Challis volcanics. The Snake River basalt at and around the station is vesicular, with jointed structure. The flood plain of Silver Creek is underlain by silt, clay, and loam enclosing a few lenses of sand. In most reaches the multiple stream channel is lined with clay and silt and a veneer of well-rounded pebble gravel (fig. 22).

Ground-water withdrawals.—During the irrigation season about 26,600 gpm of water is pumped from wells above station 24. The discharge of Silver Creek has not decreased noticeably since the wells were installed. The pumped

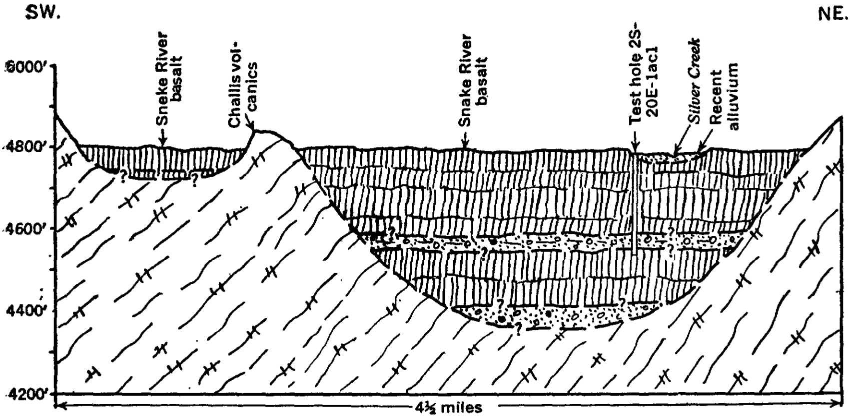

FIGURE 22.—Inferred geologic section at the site of test hole 2S-20E-1ac1, three-eighths of a mile upstream from station 24, Silver Creek, near Picabo. (Datum is sea level; note vertical exaggeration.)

water that is not consumptively used returns to Silver Creek in surface drains and by discharge from springs.

Ground-water underflow.—In 1954 the U.S. Bureau of Reclamation installed a test well and 2 observation wells about 2,000 feet southwest of station 24 (2S-21E-1ac1, 2S-21E-1ac2, and 2S-21E-1db1, table 2), where an aquifer test was made by the U.S. Geological Survey in October 1954. The aquifers tested are two groups of sand and gravel beds that are intercalated in the Snake River basalt. The full thickness of both aquifers was tapped by the test well between the depths of 185 and 206 feet. The amount of ground water moving by underflow through the aquifers was estimated by applying the formula $Q=PIA$ (see p. 19). The coefficient of permeability of the alluvium, calculated from test data, is 53,000 gpd per square foot. The hydraulic gradient is about 20 feet per mile. The inferred cross-sectional area of the aquifers, through which the ground water is moving, is 135,000 square feet (fig. 22). The computed discharge of ground water by underflow through that cross section is 30,500 acre-feet a year, which is water additional to that recorded by the gage. Permeable material in addition to that tapped by the test wells may transmit additional ungaged underflow.

In a three-quarter mile channel reach immediately upstream from station 24, and along adjacent irrigation ditches, a substantial amount of surface water enters the ground through openings in the basalt. The higher rates of loss occur during the high-water and irrigation seasons, when the stream scours its flood plain and exposes large openings in the basalt. Water flows rapidly into these openings, as is shown by whirlpools having funnel-shaped depressions ranging from 6 to 20 feet in diameter and 2 to 4 feet in depth. During periods of low flow the stream deposits an insulating mantle of silt on its flood plain and along the sides and bottom of its channels. Loss of water into the basalt has been reduced somewhat since 1951 by dikes which tend to keep the creek within its banks. The owners of the property bordering the creek report, however, that during high water stages the dikes frequently fail and allow the water to pour into the depressions adjacent to the channels. New depressions sometimes appear in ditches and cultivated land during irrigation seasons. Very probably water enters the basalt also through joints in the stream bed. It is believed that this water leaves the area as ground water in the basalt, without reappearing in Silver Creek.

Probably about 20–25 percent of the water discharged from the Silver Creek basin, and 5–10 percent of that discharged from the Ketchum and Bellevue districts, is discharged by underflow and is not gaged.

Adequacy of record.—The record is not an adequate measure of water yield of the Silver Creek basin. Furthermore, the combined records from stations 9 and 24 would not show the water yield from the Ketchum and Bellevue districts.

STATION 25. LITTLE WOOD RIVER NEAR RICHFIELD

Station location.—Recording gage in sec. 30, T. 4 S., R. 20 E., half a mile upstream from Jim Byrnes Slough and the heading of Dietrich Canal, 1 mile east of the railroad station at Richfield, and 14 miles downstream from the mouth of Silver Creek.

Records available.—January 1911 to date. Records for irrigation seasons only.

Topography.—The gaging station is on the rolling Snake River basalt plain in an area where the mantle of windblown soil is discontinuous and the basalt crops out at numerous places, especially where the basalt surface is irregular and ridged. The river is incised a few feet below the general level of the basalt surface and flows through a narrow flood plain formed by sandy silt. There are gravel bars in the channel in a few places.

Geology.—Jointed vesicular Snake River basalt crops out along both sides of the flood plain. Angular blocks of basalt are mixed with the alluvial sandy silt of the flood plain, and the river channel is paved with sand, gravel, and blocks of basalt.

Ground-water underflow.—A substantial amount of water is believed to enter openings in the Snake River basalt from the river channel between Tikura and station 25, from bypass canals between station 20 and the mouth of Silver Creek, and along Silver Creek between station 24 and the mouth. (See discussion of channel losses in Richfield district, p. 27–28.)

Adequacy of record.—The record represents the surface flow past the station during the period of record, but does not represent the water yield of the basin. The record would be useful in a study of channel losses of water in the basalt.

STATION 26. LITTLE WOOD RIVER AT SHOSHONE

Station location.—Recording gage in sec. 2, T. 6 S., R. 17 E., just upstream from diversion dam for town water supply, and 400 feet upstream from the highway bridge in Shoshone.

Records available.—April 1922 to date. Records for irrigation seasons only.

Topography.—The Little Wood River is incised a few feet below the surface of a flood plain which is about half a mile wide in the vicinity of the station. The flood plain is bordered on the south by the rolling surface of the Snake River basalt and on the north by the rough, broken surface of Recent basalt.

Geology.—The jointed and vesicular basalt which crops out at many places south of the river is part of a local flow that originated from a volcanic cone a few miles south of station 26. Presumably it is younger than much of the undifferentiated Snake River basalt. The young basalt, north of the river, consists of fresh, strongly fractured basalt that is Recent in age.

The flood-plain alluvium around the station consists of slightly compacted sandy silt with a few intercalated lenses of clay (fig. 23). Sandy silt and a small amount of fine gravel is exposed in an excavation in the flood plain just south of the station.

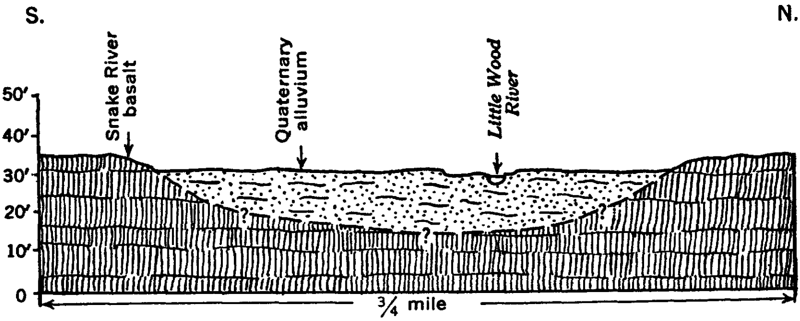

FIGURE 23.—Inferred geologic section at the site of gaging station 26, Little Wood River, at Shoshone. (Datum is arbitrary; note vertical exaggeration.)

Ground-water underflow.—An appreciable amount of water enters openings in the Snake River basalt in the reach between this station and station 25, but the loss is less than in the reach above station 25. (See discussion of channel losses in Richfield district, p. 27–28.)

Adequacy of record.—The record represents the surface flow past the station but does not represent the water yield of the basin. The records would be useful for study of channel losses from the river in the basalt area.

STATION 27. BIG WOOD RIVER NEAR GOODING

Station location.—Recording gage in sec. 21, T. 6 S., R. 14 E., at Hudson Ranch, 2 miles downstream from bridge on Bliss–Gooding highway, 3½ miles downstream from the mouth of the Little Wood River, 5 miles upstream from the diversion dam for the King Hill Project, and 6 miles southwest of Gooding.

Records available.—March 1916 to date. Records fragmentary for 1922–37, 1941, and 1942.

Topography.—The Big Wood River is incised a few feet below the general level of the surface of the Snake River basalt in the vicinity of the station and has formed a flood plain along both sides of the channel. A row of basalt ridges borders the flood plain on the west. The topography on the east is low and rolling, with few outcrops of basalt.

Geology.—The rock which crops out in the vicinity of the station is jointed Snake River basalt (fig. 24). Much of the basalt surface in this area is mantled by windblown sediments. The river flood plain is underlain by sandy silt. Gravel bars occur at places along the channel.

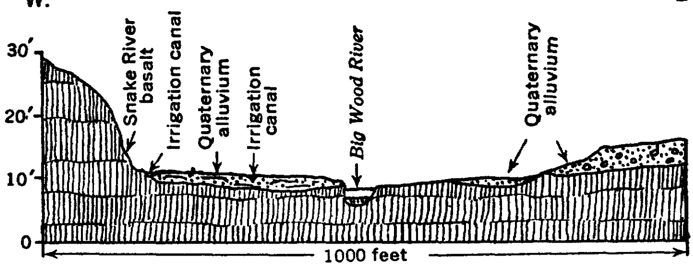

FIGURE 24.—Inferred geologic section at the site of gaging station 27, Big Wood River, near Gooding. (Datum is arbitrary; note vertical exaggeration.)

Imported recharge.—Imported Snake River water is used to irrigate land on the flood plain in several areas above the station. Some unconsumed water returns to the river by underflow through the alluvium.

Ground-water underflow.—An appreciable amount of water is lost from the channels of the Big Wood and Little Wood Rivers into the Snake River basalt above station 27. (See discussion of channel losses in Gooding district, p. 29.)

Adequacy of record.—The record represents surface flow past the station but does not represent the water yield of the basin. The record would be useful for study of channel losses in the Snake River basalt.

SUGGESTIONS FOR FURTHER STUDY

Owing to the demand for supplemental water for land already irrigated, and for water to irrigate additional land, more complete knowledge of the occurrence and availability of water in the Big Wood River basin is needed. Recent development of farmland by ground-water irrigation indicates that ground water is assuming greater importance in irrigable parts of the basin. Furthermore, interrelations between the ground water and surface water are so close that in much of the basin the use of the one directly affects the amount and availability of the other.

For the above reasons it would be prudent, before beginning further developments requiring large supplies of water, to make a careful study of the total natural water yield and the extent of current use of water in the Big Wood River basin. Such a study would be especially important in the Bellevue, Fairfield, and Muldoon districts. Somewhat different problems are apparent in the Richfield and Gooding districts where, as was noted previously, the concept of water yield has little meaning. In these two districts the surface streams at most places are perched far above the water table, and the ground water is part of a large body that receives much replenishment by underflow from eastern parts of the Snake River Plain. Some study of channel losses of water in streams and canals, as well as a reconnaissance study of ground-water resources, was made during the early period of irrigation development in the area. However, more thorough study under the present water and irrigation regimens would be very desirable.

A study of the water in the basin should include specialized methods of investigation in addition to conventional stream gaging, well inventory, ground-water observations, and hydraulic tests. Tests holes should be drilled to bedrock in lines across the valleys at key surface-water gaging-station sites to determine the profile and saturated thickness of the alluvium. Aquifer tests should be made in conjunction with the test drilling to provide data for determining the quantity of unmeasured ground-water underflow that passes beneath the gages. Supplemental local precipitation data should be obtained. Reliable data on consumptive use of water should be obtained for irrigated and nonirrigated areas. The rate of infiltration of water through soil, unconsolidated geologic materials, basalt, and bedrock should be studied, and up-to-date hydrologic maps should be made.

The product of such study in the basin would be a report embodying an estimate of the water yield of the northern districts, a segregation of surface-water runoff and ground-water underflow components of water yield, an estimate of the total depletion in the districts, and an estimate of the amount of water that remains available for use in the various areas and localities.

LITERATURE CITED

Anderson, A. L., and Wagner, W. R., 1946, Little Wood River, Muldoon District, Blaine County: Idaho Bur. Mines and Geol. Pamph. 75, p. 3–13.

Anderson, A. L., Kiilsgaard, T. H., and Fryklund, V. C., Jr., 1950, Detailed geology of certain areas in the Mineral Hills and Warm Springs mining districts: Idaho Bur. Mines and Geol. Pamph. 90, fig. 2.

Chapman, S. H., 1921, Water distribution and hydrometric work, Districts 7 and 11, Big and Little Wood Rivers: Shoshone, Idaho, Ann. Rept. Watermaster, Districts 7 and 11, 21 p., 67 charts.

Jones, R. P., 1952, Evaluation of streamflow records in Big Wood River basin, Idaho: U.S. Geol. Survey Circ. 192, 59 p.

Langbein, W. B. and others, 1949, Annual runoff in the United States: U.S. Geol. Survey Circ. 52, p. 2.

Piper, A. M., 1924, Ground water for irrigation on Camas Prairie, Camas and Elmore Counties, Idaho: Idaho Bur. Mines and Geol. Pamph. 15, 46 p.

Smith, R. O., 1959, Ground-water resources of the middle Big Wood River–Silver Creek basin: U.S. Geol. Surv. Water-Supply Paper 1478.

Stearns, H. T., Crandall, Lynn, and Steward, W. G., 1938, Geology and ground-water resources of the Snake River Plain in southeastern Idaho: U.S. Geol. Survey Water-Supply Paper 774, p. 258–262.

Umpleby, J. B., Westgate, L. G., and Ross, C. P., 1930, Geology and ore deposits of the Wood River region: U.S. Geol. Survey Bull. 814, p. 1–80.

Wenzel, L. K., 1942, Methods for determining permeability of water-bearing materials: U.S. Geol. Survey Water-Supply Paper 887, p. 3–4, 13.

RECORDS OF WELLS AND SPRINGS

The following well logs, obtained from drillers and well owners, give a fairly accurate description of the materials drilled. The drillers' terminology is largely unchanged. For a description of the well-numbering system see p. 5.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

4N-17E-13aa1. Union Pacific Railroad well

Log from Robert Strasser, driller, Dec. 20, 1954. Plentiful water between 32 and 54 ft. Water level reportedly rose to 21 ft below land surface. Well is reported to have yielded 300 gpm with a 1-ft drawdown during an 8-hour yield test conducted in September 1946]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand, gravel, and boulders, with a clay binder	32	32	Gravel and sand, loose	22	54
			Granite(?), soft, decomposed	133	187

4N-17E-15aa1. Mark Lloyd domestic well

[Log from J. Emmett Smith Drilling Co., Feb. 1953. Water at 18, 65, 92, and 195 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel and boulders	4	4	Rock, dark-gray	8	100
Gravel, cemented	14	18	Rock, gray, soft	50	150
Gravel	19	37	Rock, gray, hard	22	172
Rock, white	21	58	Rock, white, soft	14	186
Rock, dark	6	64	Rock, gray, loose	8	194
Rock, loose	1	65	Rock, gray, hard	18	212
Rock, dark	5	70	Rock, gray	5	217
Rock, gray, hard	22	92			

4N-18E-7dc1. Ketchum public-supply well No. 2

[Log from J. Emmett Smith, driller, Dec. 13, 1954. Plentiful water between 10 and 48 ft. Water level reportedly rose from 10 to 4 ft below land surface]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	4	4	Gravel	3	48
Gravel, coarse	24	28	Rock, red	10	58
Gravel with some clay	17	45			

4N-18E-8bc1. Ketchum public-supply well No. 1

[Log from J. Emmett Smith Drilling Co., Nov. 6, 1952. Water at 55, 91, 100, 151 and 175 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	20	20	Clay, sticky; some sand	20	195
Clay and gravel	20	40	Clay, blue, very sticky	86	281
Clay, with thin layer of sand	15	55	Sand, blue-gray	6	287
Clay	35	90	Clay, blue-gray	16	303
Sand	1	91	Sand or sandstone, soft	7	310
Clay, with thin layers of sand	9	100	Clay	35	345
			Sand or sandstone	15	360
Clay, mixed with fine gravel	20	120	Clay	40	400
Clay, blue, tough	40	140	Sand or sandstone	35	435
Clay, mixed with fine gravel	10	150	Clay	40	475
Sand	1	151	Sand and sandstone	15	490
Clay, mixed with sand	19	170	Clay	50	540
Clay, with thin layers of gravel	5	175	Sand and sandstone	10	550
			Clay	36	586

4N-18E-18cb1. Rancho Thunderbird domestic well

[Log from E. W. Walker, driller, Nov. 7, 1952. Water at 54 ft. Bailed 20 gpm]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Boulders, large	48	48	Gravel	18	66

4N-18E-19cd1. Jack Lane domestic well

[Log from J. Emmett Smith Drilling Co., Nov. 5, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Old well	57	57	Limestone, black	119	189
Sand, clay, and pea-sized gravel	13	70			

3N-18E-18ac1. Glendale Farms, Inc.

Log from E. W. Walker, driller, Nov. 20, 1954. Plentiful water between 17.5 and 30 ft and between 35 and 55 ft. Water level reportedly rose to 13 ft below land surface]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Clay	1	31
Boulders and gravel	12	15	Gravel, coarse	4	35
Gravel, coarse	5	20	Sand and gravel	20	55
Sand and gravel	10	30			

1N-18E-1da1. Bureau of Reclamation test hole 1

[Log from J. Emmett Smith Drilling Co., July 15, 1954]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil, gravel, and cobbles	6	6	Gravel, fine, and sand; traces of clay between 78 and 84 ft. First water at 37 ft; plentiful water at 80 ft	54	84
Gravel and sand, with traces of clay	24	30	Sand and fine gravel	1	85

1N-19E-6cb1. 122 Ranch, Inc. irrigation well

[Log from Western Drilling Co., Nov. 6, 1952. Water at 45 ft. Water level reportedly rose to 41 ft below land surface]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	2	2	Sandy formation, dark blue, hard	0.4	81.4
Gravel, interbedded with black loam	79	81			

1N-19E-31ca1. Base Line Canal Co. irrigation well

[Log from George Roessler, driller, Sept. 30, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Clay, sticky	8	48
Gravel, coarse	37	40	Gravel, coarse	22	70

1N-19E-32ab1. John Browning domestic well

[Log from E. W. Walker, driller, Nov. 6, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	5	5	Clay	2	78
Sand and gravel, with traces of clay	54	59	Sand and gravel	5	83
Sand and gravel	17	76	Sand, clean, fine	3.5	86.5

1N-19E-33db1. Clarence Allred irrigation well

[Log from George Roessler, driller, Sept. 30, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	4	4	Sand	14	42
Gravel, coarse	24	28	Gravel, coarse	30	72

1N-20E-12cc1. U.S. Bureau of Reclamation test hole

[Log from E. L. White, Bureau of Reclamation area engineer, Dec. 3, 1954. Plentiful water at 127.7 ft, 143.4 to 174.9 ft, and 180.0 to 183.7 ft. Water level reported to be 130 ft below land surface Sept. 29, 1954]

	Thickness (feet)	Depth (feet)
Silt	3.1	3.1
Basalt, dark-gray; vesicles up to ¾-in. diameter; all joints nearly horizontal. Core in sections as long as 3 ft. Some thin deposition of calcite in joints and voids. Basalt becomes less vesicular and more dense from 9.3 to 25.5 ft	22.4	25.5
Sand, light-brown, medium-grained; some stream-worn gravel of rhyolitic composition	9.5	35.0
Clay, light-brown, sandy. Easily cored	3.1	38.1
Basalt, dark-gray, very vesicular. Joints contain light-brown sandy clay material; upper 4 in. is weathered and iron stained. Core pieces are 1 ft long. This was probably a large boulder	5.9	44.0
Clay, light-brown, sandy. A section of core 0.8 ft long was recovered	.9	44.9
Basalt, dark-gray, vesicular. Most joints are horizontal and some contain a tan clayey substance. Core in sections as long as 3.7 ft. Becomes dense with few voids from 54.1 to 68.2 ft	23.3	68.2
Basalt, dark-gray, very vesicular. Most joints are horizontal and some contain a tan clayey substance. Core in sections as long as 3.7 ft. Basalt has appearance of interflow zone between 68.2 and 71.9 ft but becomes dense with few voids from 79.3 to 96.4 ft	28.2	96.4
Basalt, dark-gray, very vesicular and broken. Most joints are horizontal and some contain a tan clayey substance. Core in sections as long as 3.7 ft. Basalt has appearance of interflow zone between 96.4 and 99.9 ft but is dense with few voids from 99.9 to 108.1 ft and between 113.1 and 123.3 ft	27.1	123.5
Basalt, dark-gray, vesicular. Most joints are horizontal and some contain a tan clayey substance. Core in sections as long as 3.7 ft. Basalt has appearance of interflow zone between 123.5 and 125.0 ft but becomes dense with few voids from 134.0 to 141.6 ft	19.9	143.4
Sand and gravel, stream-worn. Most particles of gravel are quartzite or rhyolite; very little basalt noted in sample (water)	31.5	174.9
Clay, grayish-tan, plastic; contains some silt	5.1	180.0
Sand and gravel, stream-worn; same as from 143.7 to 174.9 ft (water)	3.7	183.7

1S-14E-10ca1. Church of Jesus Christ of Latter-day Saints well

[Log from George G. Perkins, driller, Nov. 1952. The nature of the materials called "hard flow cap" and "rubbery flow cap" by the driller was not determined. Well was brought in Dec. 6, 1940; tested again Dec. 30, 1940, with artesian flow of 43 gpm, temperature 64° F, and pressure 14½ psi. Water found as follows: 92–94 ft, small free flow, temperature 51° F, pressure too slight to measure with gage; 188–236 ft, free flow of 8 gpm, temperature 54° F, pressure 6½ psi, very poor water containing sulfur and iron; 290–292 ft, free flow of 9 gpm, temperature 56° F, pressure 8 psi; 368–379 ft, free flow of 13 gpm, temperature 58° F, pressure 11 psi; 447 ft, free flow of 31 gpm, temperature 62° F, pressure 14½ psi, good water]

	Thickness (feet)	Depth (feet)
Loam, black	2	2
Gravel	6	8
Clay, yellow	8	16
Gravel	6	22
Quicksand, white, sharp	16	38
Clay, yellow	17	55
Sand	1	56
Hardpan	26	82
Sand, cemented	2	84
Flow cap, black, hard	8	92
Sand, flour-fine (water)	2	94
Clay, blue	3	97
Sand	1	98
Sand, fine; blue clay generally found at this depth in this area	5	103
Gravel, coarse	35	138
Quicksand, blue	18	156
Clay, blue	32	188
Sand, blue, fine (water)	48	236
Clay, blue; interbedded with bright-blue fine sand that contains mica	52	288
Flow cap	2	290
Sand; contains water under artesian pressure	2	292
Clay, blue	11	303
Flow cap, black, hard. Driller reported slow drilling	65	368
Sand; contains water under artesian pressure	11	379
Sand, bright-yellow, cemented; interbedded with 3- to 5-in. beds of white clay. Driller reported hard drilling	26	405
Flow cap, white, rubbery. Could not be drilled by spudding motion; used rotary drill. Struck water	36	441
Sand, yellow, coarse; contains water under artesian pressure	6	447

1S-18E-2dd2. L. J. Lawson irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952. Water at 8 and 27 ft; water under artesian pressure below 118 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel	20	20	Sand, brown, loose	77	104
Clay, brown	7	27	Clay, brown, sticky	14	118

1S-18E-11ad1. Crystal Farms Co. irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel with some sand	42	42	Clay, blue, impervious	22	107
Clay, brown	1	43	Clay, brown, gummy	10	117
Clay and loose sand	21	64	Gravel; contains water under artesian pressure	1	118
Sand, loose	21	85			

1S-18E-12ba1. Wayne Clark irrigation well

[Log from J. Emmett Smith Drilling Co., Oct. 15, 1951]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil, gravel, and clay	17	17	Clay, cream-colored, sticky	15	136
Sand and clay, light-brown	63	80	Sand and gravel; contains water under artesian pressure	4	140
Sand, brown, loose	26	106			
Sand and blue clay	15	121			

1S-18E-13ac1. Winton Gray irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Dug well	20	20	Gravel and sand, coarse; contains water under artesian pressure	?	?
Gravel	20	40			
Sand, brown, loose	30	70			
Clay, light-blue	90	160			

1S-18E-24bb1. J. E. Fredrickson irrigation well

[Log from George Roessler, driller, Sept. 1952. Well reportedly flowed 845 gpm at completion of drilling]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel, fine, and clay	30	30	Gravel, medium; contains water under artesian pressure	2	126
Clay, blue	94	124			

1S-19E-4bc1. Clarence Allred irrigation well

[Log from George Roessler, driller, Sept. 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	4	4	Sand	20	50
Sand and gravel	26	30	Gravel, coarse	10	60

1S-19E-8cd1. Otis Chaumell irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952. Water at 5 to 12 ft, 147 to 150 ft, 162 ft, and 218 ft. Well flowed 270 gpm at completion of drilling]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	12	12	Clay, dry	2	161
Gravel	28	40	Gravel	1	162
Sand	10	50	Clay, blue, and gravel	24	186
Clay, brown	7	57	Gravel	8	194
Sand, brown	25	82	Clay	24	218
Clay, brown	19	101	Sand and fine gravel; contains water under artesian pressure	1	219
Clay, blue, sandy	9	110	Clay, brown	25	244
Clay, blue	37	147			
Sand, brown	3	150			
Clay, brown, sticky	9	159			

1S-19E-18ca1. Henry Wurst irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952. Well flowed 648 gpm at completion of drilling]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay	18	18	Sand and gravel; contains water under artesian pressure	1.5	173.5
Clay and gravel	9	27	Clay, blue	.5	174
Sand, brown, loose	48	75			
Sand, blue, loose	15	90			
Clay, blue	80	170			
Clay, brown, gummy; some gravel	2	172			

1S-19E-22aa1. Blaine County test well

[Log from J. Emmett Smith, driller, Aug. 4, 1954. Water at 13 ft and water under artesian pressure between 80 and 95 ft. Pressure head 8.0 ft above land surface, Aug. 11, 1954]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	6	6	Gravel, composed of basalt particles, and clay	2.8	97.8
Topsoil, sandy, and gravel	4	10	Clay and loose basalt	12.2	110
Sand and some pea gravel	5	15	Sand and clay	5	115
Gravel, pea and sand	5	20	Basalt(?)	5	120
Sand, pea gravel, and clay	30	50	Basalt, blue-gray, hard	5	125
Clay	18	68	Clay and loose basalt	12	137
Clay and pea gravel	11	79	Basalt, blue-gray, hard	3	140
Sand	6	85	Clay and loose basalt	5	145
Gravel, composed of basalt particles	10	95	Basalt, blue-gray, broken	5	150

1S-20E-19ac1. Gary Castle irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952. Artesian water between 37 and 43 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Pit	5	5	Cinders	6	43
Topsoil	14.5	19.5	Basalt, black	8	51
Basalt, black, hard	17.5	37			

1S-20E-19cd1. Albrethson Hereford Ranch irrigation well

[Log from E. W. Walker, driller, Nov. 6, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil and clay	12	12	Clay, blue	5	36
Gravel, medium; and sand	19	31			

1S-20E-27bd1. Blaine County test well

[Log from J. Emmett Smith, driller, Aug. 13, 1954. Water between 6 and 9 ft, between 95 and 100 ft, and water under artesian pressure between 133 and 140 ft. Water level 58.6 ft below land surface, Sept. 24, 1954]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil and clay	6	6	Clay, blue, very sticky	10	85
Gravel, coarse	3	9	Gravel, sand and clay	6	91
Clay and gravel, pea-sized and larger	16	25	Basalt, gray	4	95
Clay, blue, and gravel, pea-sized and larger	12	37	Basalt, gray, with brownish tinge, porous	5	100
Clay, blue, and sand; partially decayed wood between 45 and 50 ft	13	50	Basalt, gray, hard	27	127
Sand, dark-gray	15	65	Basalt, broken and creviced	3	130
Sand, dark-gray, and clay	10	75	Clay, green and yellow, mixed	3	133
			Basalt, gray, porous	7	140

1S-21E-16cd2. J. E. Peterson irrigation well

[Log from Western Drilling Co., Nov. 6, 1952. Water at 28 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Gravel	99	102

1S-22E-7db1. Miles Reay domestic well

[Log from E. W. Walker, driller, Nov. 6, 1952. Water at 62 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	2	2	Basalt, black	113	115

2S-20E-1ac1. R. N. Leazenby test well

[Log from J. Emmett Smith, driller, Sept. 1954. Plentiful water between 183 and 192 ft and between 197 and 202 ft. Water level rose to 142.3 ft below land surface]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	2	2	Basalt, gray	13	143
Clay, yellow	5	7	Basalt, gray, and clay	7	150
Basalt, gray, broken	23	30	Basalt, gray	33	183
Basalt, pinkish, broken	42	72	Sand, pea-sized gravel, and larger gravel	9	192
Basalt, gray, broken	20	92	Clay, yellow, and sand	5	197
Basalt, pinkish-gray, broken; mixed with abundant yellow clay	23	115	Sand and gravel	5	202
Basalt, gray	10	125	Clay, sand, pea-sized gravel, and some coarse gravel	16	218
Basalt, pinkish-gray, broken	5	130	Clay, cream-colored, sticky	7	225
			Basalt, dark-gray, porous	25	250

2S-21E-3cd1. Valdo Benson domestic well

[Log from E. W. Walker, driller, Nov. 6, 1952. Water at 134, 143, 167, and 175 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel	38	38	Clay, brown	7	174
Basalt, gray, hard	64	102	Cinders	10	184
Gravel	65	167			

6S-14E-23bb1. J. H. Glandon domestic and stock well

[Log from J. Emmett Smith, driller, Nov. 8, 1951. Water level reported to be 263 ft below land surface, Apr. 19, 1951]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Pit	6	6	Creviced formation	25	215
Creviced formation and loose rock	44	50	Basalt, gray, very hard	25	240
Basalt, brown	40	90	Basalt and cinders, red; and clay	20	260
Creviced formation	25	115	Basalt, gray	25	285
Basalt, gray to brown	30	145	Crevice	1	286
Crevice	2	147	Rock, porous	2	288
Basalt, gray, hard	43	190			

6S-17E-2ab1. City of Shoshone well

[Log from City Clerk, Nov. 1, 1952]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	2	2	Clay, brown; and basalt	8	183
Hardpan	4	6	Cinders, black	3	186
Clay	4	10	Basalt, gray	9	195
Basalt, broken; some sand	3	13	Cinders	15	210
Basalt, gray	14	27	Basalt, black, hard	26	236
Basalt, red; crevices	9	36	Basalt, gray, soft	14	250
Basalt, gray	7	43	Basalt, black	30	280
Basalt, gray, hard	35	78	Basalt, red; some clay	12	292
Basalt, gray, soft	9	87	Basalt, black	13	305
Basalt, gray	18	105	Basalt, gray	10	315
Basalt, dark-gray, soft	7	112	Basalt, black	15	330
Basalt, brown, fairly hard	63	175	Basalt, red	25	355

TABLE 2.—*Records of wells and springs in the Big Wood River basin*

Well and spring numbers: See p. 5 and fig. 2 for description of numbering system.
Type of well: Dr, drilled; Du, dug; S, spring.
Depth of well: Measured depths are given in feet and tenths below land-surface datum; reported depths are given in whole feet below land-surface datum.
Type of casing: WI, wrought iron; GI, galvanized iron; Rk, rock; W, wood.
Geologic source of water: Al, alluvium; Cv, Challis volcanics; Gt, gravel and tuff; Ib, rocks of Idaho batholith and broadly related rocks; Mw, Milligen and Wood River formations; Sb, Snake River basalt.
Method of lift: C, cylinder; A, artesian pressure; J, jet; N, none; T, turbine.
Type of power: E, electric motor; D, diesel engine.
Use of water: D, domestic; I, irrigation; N, none; O, observation; RR, railroad; S, stock; PS, public supply; B, bathing; FH, fish hatchery.
Depth to water: Measured depths to water level are given in feet and tenths; reported depths are given in whole feet.

Well or spring No.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well casing (inches)	Type of casing	Geologic source of water	Method of lift and type of power	Use of water	Depth to water level below land surface (feet)	Date of measurement	Remarks
4N-17E-13aa1	Union Pacific RR	Dr	187	12	WI	Al	T, E	RR	21	9-46	Reported drawdown 1 ft while discharging 300 gpm.
15aa1	Mark Lloyd	Dr	217	6	WI	Al, Mw	N	N	12.3	4-14-53	
15bbS1	C. A. Brandt	S				Mw	A	B		Summer 1923	Reported discharge 1,800 gpm, temp. 159° F.
4N-18E-7bc1	City of Ketchum	Dr	586	12	WI	Al, Gt	T, E	PS	40	4-12-53	Reported drawdown 120 ft while discharging 350 gpm.
7dc1	do	Dr	58	12	WI	Al	T, E	PS	10.9	11-28-54	Reported drawdown 3 ft while discharging 825 gpm.
18cb1	Rancho Thunderbird	Dr	66	6	WI	Al	J, E	D		11-7-52	Reported discharge 20 gpm.
19cd1	Jack Lane	Dr	189	5¼	WI	Al	J, E	D	20	6-1-50	
22cbS1	Triumph Mine	S				Mw, Cv	A	N		12-24-52	Reported discharge 3,000 gpm.
3N-18E-18ac1	Glendale Farms, Inc.	Dr	55	8	WI	Al	N		13	11-13-54	Reported discharge 903 gpm.
2N-18E-9bd1	City of Hailey	Du	11	84×144	Rk, W	Al	T, E	PS	7.1	10-2-52	Reported discharge 1,500 gpm.
15cc1	K. Beecher and others	Du	10			Al	C, E	I	1.7	9-30-52	Reported drawdown 6 ft while discharging 3,000 gpm.
26dc1	W. E. Stewart	Du	22.9			Al	T, E	I	4.5	9-30-52	Reported drawdown 2 ft while discharging 2,250 gpm.
1N-13E-32abS1	Wesley Fields	S				Ib	A	B		Summer 1924	Temp. 150° F.
1N-15E-32aoS1	Edna Peck	S				Cv	A	I		Summer 1924	Reported discharge 50 gpm, temp. 50° F.
1N-18E-1da1	Upper Big Wood River Canal Co.	Dr	85	6	WI	Al	N	O	39.5	7-22-54	Test well.
1N-19E-6cb1	122 Ranch, Inc.	Dr	81	18	WI	Al	T, E	I	41.2	9-30-52	Discharge 1,350 gpm.
31ca1	Base Line Canal Co.	Dr	72	16	WI	Al	T, E	I	37.0	9-30-52	Discharge 1,500 gpm.
32ab1	John Browning	Dr	87	6	WI	Al	C, E	D	36.0	9-14-54	
33db1	Clarence Allred	Dr	70	16	WI	Al	T, E	I	21.7	8-11-54	Discharge 2,700 gpm.
1N-20E-12cc1	U.S. Bureau of Reclamation.	Dr	183.7	2⅞	GI	Al, Sb	N		127	9-29-54	Test well.

1S-14E-10ca1	Church of Jesus Christ of Latter-day Saints.	Dr	447	2	GI	Al	A	D	----------	12- 6-40	Reported discharge 43 gpm.
1S-18E-2dd2	L. J. Lawson	Dr	118	8¼	WI	Al	A	I	+22.6	8-12-54	Discharge 1,100 gpm.
11ad1	Crystal Farms Co.	Dr	118	8	WI	Al	A	I	+34.8	8-12-54	Discharge 1,525 gpm.
12ba1	Wayne Clark	Dr	140	6¼	WI	Al	A	I	+13.9	8-12-54	Discharge 645 gpm.
13ac1	Winton Gray	Dr	160	6¼	WI	Al	A	I	+32.8	8-12-54	Reported discharge 1,325 gpm.
14aa1	Frank Gomes	Dr	120	6	WI	Al	A	I	+37.6	8-12-54	Discharge 1,425 gpm
24bb1	J. E. Fredrickson	Dr	122	6	WI	Al	A	I	----------	4-15-53	Reported discharge 900 gpm.
1S-19E-2cb1	A. A. Rhodes	Du	23	42	GI	Al	T, E	I	6.9	9-18-52	Discharge 2,500 gpm.
3cc1	Jack Allred	Dr	50	14	WI	Al	T, E	I	8.3	10- 2-52	Discharge 2,175 gpm.
4bc1	Clarence Allred	Dr	60	10	WI	Al	T, E	I	14.4	9-18-52	Discharge 3,000 gpm.
8cd1	Otis Chaumell	Dr	244	8	WI	Al	A	I	+17.5	8-12-54	
10aa1	E. W. Byington	Du	14	48×72	W	Al	D	I	6.3	10-22-52	Reported drawdown 6 ft while discharging 1,700 gpm.
13bbS1	Idaho Fish and Game	S	----------	----------	----------	Mw(?)	A	FH	----------	4-13-53	Reported discharge 300 gpm, temp. 53° F.
13bdS1	do	S	----------	----------	----------	Mw(?)	A	FH	----------	11-18-52	Reported discharge 480 gpm, temp. 53° F.
18ca1	Henry Wurst	Dr	172	8	WI	Al	A	I	+28.2	8-11-54	Reported discharge 650 gpm, temp. 58° F.
22aa1	Blaine County	Dr	150	6	WI	Al, Sb	A	N	+8.0	8-11-54	Test well.
1S-20E-19ac1	Gary Castle	Dr	51	6	WI	Sb	J, E	D	10.1	7- 9-54	
19cd1	Albrethson Ranch	Dr	36	14	WI	Al	T, E	I	5.1	10-22-52	Discharge 565 gpm.
27bd1	Blaine County	Dr	140	6	WI	Al, Sb	N	O	31.6	8-13-54	Test well.
1S-21E-16cd2	J. E. Peterson	Dr	102	20	WI	Al	T, E	I	23.5	4-10-53	Reported discharge 1,800 gpm.
1S-22E-7db1	Miles Reay	Dr	115	8	WI	Sb	T, E	D	162	4-48	
2S-20E-1ac1	R. N. Leazenby	Dr	250	6	WI	Al	N	----------	142.3	9- 8-54	Test well.
1ac2	do	Dr	209	10	WI	Al	N	O	143.8	10-18-54	Drawdown 7.5 ft while discharging 780 gpm.
1db1	do	Dr	194	8	WI	Al	N	----------	143.2	8-13-54	Test well.
2S-21E-3cd1	Valdo Benson	Dr	184	8¼	WI	Sb	J, E	D, S	109	4-10-53	
4S-19E-25ba1	Charles McKay	Dr	210	6	WI	Sb	N	O	115.4	4-15-52	
6S-14E-23bb1	J. H. Glandon	Dr	288	4	WI	Sb	F, E	D, S	263	4-19-51	
6S-17E-2ab1	City of Shoshone	Dr	355	20	WI	Sb	T, E	PS	176	11- 1-52	Reported discharge 1,350 gpm.

INDEX

O