STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
Carson City

Independence Mountains.

WATER RESOURCES – RECONNAISSANCE SERIES

REPORT 48

WATER–RESOURCES APPRAISAL OF THE SNAKE RIVER BASIN IN NEVADA

By
Donald O. Moore
and
Thomas E. Eakin

Prepared cooperatively by the
Geological Survey, U.S. Department of the Interior

JULY 1968

115 pages 13.48
1 map 1.00
$ 14.48

COVER PHOTOGRAPH

View of the northern Independence Mountains from Maggie Summit. Photo by Jim Reinheller, Nevada Department of Highways.

WATER RESOURCES - RECONNAISSANCE SERIES

REPORT 48

WATER-RESOURCES APPRAISAL OF THE SNAKE RIVER BASIN IN NEVADA

By

Donald O. Moore

and

Thomas E. Eakin

Prepared cooperatively by the

Geological Survey, U.S. Department of the Interior

July

1968

ELMO J. DeRICCO
Director

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
201 South Fall Street, Carson City, Nevada 89701

ROLAND D. WESTERGARD
State Engineer

In reply refer to
No.

Address All Communications to the State Engineer, Division of Water Resources

FOREWORD

This appraisal of the water resources of the Snake River basin in Nevada is a part of the continuing reconnaissance of the water resources of Nevada. The description and preliminary quantitative estimates of elements of the hydrologic system forms the basis for a better understanding of the magnitude of the water generated in Nevada, the water available in Nevada, and the outflow to adjacent States.

Roland D. Westergard
State Engineer

Division of Water Resources

July 1968

CONTENTS

	Page
Summary	1
Introduction	3
Purpose and scope of report	3
Previous investigations	3
Acknowledgments	5
Location and general features	5
Physiography and drainage	6
Precipitation	8
Evapotranspiration	18
Ground water	22
Hydrogeology	22
Occurrence	23
Movement	24
Storage	24
Recharge	25
Discharge	27
Surface water	30
Goose Creek Valley	31
Drainage	31
Records available	31
Characteristics of streamflow	31
Estimated runoff	35
Inflow and outflow	35
Salmon Falls Creek Valley	35
Drainage	35
Records available	37
Characteristics of streamflow	38
Estimated runoff	38
Inflow and outflow	43
Bruneau River Valley	43
Drainage	43
Records available	43
Characteristics of streamflow	44
Estimated runoff	44
Inflow and outflow	44
Jarbidge River Valley	44
Drainage	44
Records available	52
Characteristics of streamflow	53
Estimated runoff	53
Inflow and outflow	53

Surface water--continued Page

Owyhee River Valley 58
Drainage 58
Records available 58
Characteristics of streamflow 60
Estimated runoff 60
Inflow and outflow 65
South Fork Owyhee River Valley 65
Drainage 65
Records available 66
Characteristics of streamflow 67
Estimated runoff 67
Inflow and outflow 67
East Little Owyhee River Valley 72
Drainage 72
Records available 72
Characteristics of streamflow 72
Estimated runoff 72
Inflow and outflow 72
Summary of surface water 75

Hydrologic budget 77
Perennial yield 79

Chemical quality 81

Use of water 84

Designation of wells and springs 87

References cited 100

List of previously published reports 102

ILLUSTRATIONS

			Page
Plate	1.	Generalized hydrogeologic map of Snake River basin in Nevada	Back of report
Figure	1.	Areas in Nevada described in previous reports of the Water Resources Reconnaissance Series and the area described in this report	4
	2.	Map showing general location of precipitation and temperature gages	10
	3.	Graphs showing distribution of precipitation by months at Tuscarora, Jarbidge, Owyhee, and Montello, Nev., for the period 1939-60	11
	4.	Graphs showing cumulative departure curves for average precipitation at Jarbidge, Owyhee, and Montello, Nev., for the period 1939-60	12
	5.	Graphs of approximate relation of precipitation to altitude in Snake River basin in Nevada	15
	6.	Graphs showing distribution by months and year of temperature at Owyhee and Jarbidge, Nev., 1939-60	19
	7.	Graphs showing monthly discharge as a percentage of mean annual discharge of Goose Creek above Trapper Creek near Oakley, Idaho, 1920-65	33
	8.	Graphs showing monthly discharge as a percentage of mean annual discharge of Salmon Falls Creek	41
	9.	Graphs showing monthly discharge as a percentage of mean annual discharge of Bruneau River near Rowland, Nev., 1914-18	50
	10.	Graphs showing monthly discharge as a percentage of mean annual discharge of East Fork Jarbidge River near Three Creek, Idaho, 1954-65	56
	11.	Graphs showing monthly discharge as a percentage of mean annual discharge of Owyhee River at Mountain City, Nev. prior to regulation, 1928-37	62

Illustrations--continued

		Page
Figure 12.	Graphs showing monthly discharge as a percentage of mean annual discharge of Owyhee River . . .	63
13.	Graphs showing monthly discharge as a percentage of mean annual discharge at South Fork Owyhee River	70

TABLES

			Page
Table	1.	Summary of precipitation gages in and adjacent to the Snake River basin	9
	2.	Average water content on April 1 and May 1 for snow courses in Jack Creek basin for period 1957-61	13
	3.	Estimated average annual precipitation for the Snake River basin in Nevada	16
	4.	Estimated average annual losses by evapotranspiration from surface water and ground water in the lowlands of the Snake River basin in Nevada.	20
	5.	Summary of streamflow, in cfs, at gaging station on Goose Creek	32
	6.	Miscellaneous streamflow measurements made in Goose Creek Valley	34
	7.	Estimated average annual runoff in Goose Creek Valley	36
	8.	Summary of streamflow, in cfs, at gaging station in Salmon Falls Creek Valley	39
	9.	Miscellaneous streamflow measurements made in Salmon Falls Creek Valley	40
	10.	Estimated average annual runoff in Salmon Falls Creek Valley	42
	11.	Summary of streamflow, in cfs, at gaging station in Bruneau River Valley	45
	12.	Miscellaneous streamflow measurements made in Bruneau River Valley	46
	13.	Estimated average annual runoff in Bruneau River Valley	51
	14.	Summary of streamflow, in cfs, at gaging station in Jarbidge River Valley	54
	15.	Miscellaneous streamflow measurements in Jarbidge River Valley	55

Tables--Continued

Page

Table 16. Estimated average annual runoff in Jarbidge River Valley 57

17. Summary of streamflow, in cfs, at gaging stations in the Owyhee River Valley 59

18. Miscellaneous streamflow measurements made in the Owyhee River Valley 61

19. Estimated average annual runoff in Owyhee River Valley 64

20. Summary of streamflow, in cfs, at gaging stations in South Fork Owyhee River Valley 68

21. Miscellaneous streamflow measurements made in South Fork Owyhee River Valley 69

22. Estimated average annual runoff in South Fork Owyhee River Valley 71

23. Miscellaneous streamflow measurements in East Little Owyhee River Valley 73

24. Estimated average annual runoff in East Little Owyhee River Valley 74

25. Summary of estimated runoff, inflow, and outflow for the Snake River basin in Nevada 76

26. Summary of estimates of some components of the hydrologic system 78

27. Partial and detailed chemical analyses of water from wells, springs, and streams 82

28. Records of selected wells 88

29. Selected well logs 95

WATER-RESOURCES APPRAISAL OF THE SNAKE RIVER BASIN IN NEVADA

By Donald O. Moore and Thomas E. Eakin

SUMMARY

The Snake River basin in Nevada includes an area of about 5,000 square miles in northern Elko and northeastern Humboldt Counties. Nearly all the area is above an altitude of 5,000 feet. Jarbidge Peak, altitude 10,789 feet, is the highest point.

The central highlands, which include Jarbidge, Bull Run, and Independence Mountains, receives relatively heavy precipitation. The highlands are the headwaters for the major streams including from west to east, the South Fork Owyhee, Owyhee, Bruneau, Jarbidge Rivers, and Salmon Falls Creek.

The relatively steep gradients and deeply entrenched streams strongly influence the hydrology of the basin. These features combine to produce relatively high runoff, restrict natural areas of evapotranspiration of surface water and ground water, and have the streams function as ground-water drains.

It is estimated that precipitation on the basin may average about 3.9 million acre-feet a year. However, on the order of 83 percent of the precipitation is lost by evapotranspiration about where it falls, whether immediately or after a period of temporary storage mainly as snow or soil moisture.

Of the estimated 680,000 acre-feet of average annual runoff generated in Nevada, about half a million acre-feet leaves the State as streamflow. Streamflow into Nevada from the Idaho part of Goose Creek and Salmon Falls Creek Valleys is estimated to average about 17,000 acre-feet a year. The net streamflow from Nevada into Idaho for Goose Creek, Salmon Falls Creek, Bruneau River, Jarbidge River, Owyhee River, South Fork Owyhee River, and East Little Owyhee River areas is estimated to average about 23,000, 88,000, 96,000, 93,000, 90,000, 100,000, and 6,000 acre-feet a year, respectively.

Surface water and ground water are closely interrelated. Along the flood plain, high stream stages tend to recharge the ground-water system. But ground water tends to discharge to the streams during periods of low streamflow. Potential recharge has been estimated to be roughly 150,000 acre-feet a year.

However, much of the potential recharge is rejected or part returns to the streams to leave the State as streamflow. About 46,000 acre-feet of ground water is lost by evapotranspiration on the flood-plain areas.

In Nevada, development of surface water through reservoir storage is largely confined to the Owyhee and South Fork Owyhee River systems. Wild Horse Reservoir (capacity 32,690 acre-feet) is being enlarged to about 70,000 acre-feet by construction of a new dam. Smaller reservoirs, include Sheep Creek, Deep Creek, Wilson Creek, Bull Run, Rawhide, and I. L. Charleston Reservoir is on the Bruneau River. These reservoirs provide for limited storage and regulation of the streams. However, the principal reservoirs are downstream from Nevada.

To date, ground-water development by wells has been small. Several wells are used for supplemental irrigation in Independence, Salmon Falls Creek, and Goose Creek Valleys; but the annual withdrawals have been small. Two irrigation wells currently in use in Independence Valley obtain water from valley fill, two flowing wells in Goose Creek Valley apparently obtain their water from carbonate rocks, and two new wells in northern Salmon Falls Creek Valley obtain their water from volcanic or associated sedimentary rocks. The wells that tap the volcanic rocks have the largest yields--one of these reportedly flows about 1,250 gallons a minute and the other pumps about 2,500 gallons a minute. These large yields cannot be expected everywhere in the basin, but do suggest that possibilities exist.

Additional development of water in the Snake River basin in Nevada is possible, but only subject to existing water rights and agreements. On the premise of perennial-yield concept, development might salvage as much as 45,000 acre-feet of ground water a year now lost by evapotranspiration in the flood-plain areas. Most of this may be recoverable in Independence, Duck, and lower Salmon Falls Creek Valleys where ground-water losses by evapotranspiration are estimated to be about 15,000, 3,600, and 7,400 acre-feet a year, respectively. Increased pumping probably would induce greater recharge from present streamflow. This would affect streamflow but could be beneficial in providing a means of further regulation of the flow system in the basin.

The few selected chemical analyses suggest that the surface water and ground water commonly are of good quality. Most of the analyses indicate water classified as having medium salinity and low alkali hazards. Two river and two ground-water samples, analyzed for boron, indicated a concentration of 0.1 mg/l or less. Water commonly is hard. The low chemical concentrations of most of the samples analyzed is consistent with the apparently free circulation of the surface- and ground-water systems in the basin.

WATER-RESOURCES APPRAISAL OF THE SNAKE RIVER BASIN IN NEVADA

By Donald O. Moore and Thomas E. Eakin

SUMMARY

The Snake River basin in Nevada includes an area of about 5,000 square miles in northern Elko and northeastern Humboldt Counties. Nearly all the area is above an altitude of 5,000 feet. Jarbidge Peak, altitude 10,789 feet, is the highest point.

The central highlands, which include Jarbidge, Bull Run, and Independence Mountains, receives relatively heavy precipitation. The highlands are the headwaters for the major streams including from west to east, the South Fork Owyhee, Owyhee, Bruneau, Jarbidge Rivers, and Salmon Falls Creek.

The relatively steep gradients and deeply entrenched streams strongly influence the hydrology of the basin. These features combine to; produce relatively high runoff, restrict natural areas of evapotranspiration of surface water and ground water, and have the streams function as ground-water drains.

It is estimated that precipitation on the basin may average about 3.9 million acre-feet a year. However, on the order of 83 percent of the precipitation is lost by evapotranspiration about where it falls, whether immediately or after a period of temporary storage mainly as snow or soil moisture.

Of the estimated 680,000 acre-feet of average annual runoff generated in Nevada, about half a million acre-feet leaves the State as streamflow. Streamflow into Nevada from the Idaho part of Goose Creek and Salmon Falls Creek Valleys is estimated to average about 17,000 acre-feet a year. The net streamflow from Nevada into Idaho for Goose Creek, Salmon Falls Creek, Bruneau River, Jarbidge River, Owyhee River, South Fork Owyhee River, and East Little Owyhee River areas is estimated to average about 23,000, 88,000, 96,000, 93,000, 90,000, 100,000, and 6,000 acre-feet a year, respectively.

Surface water and ground water are closely interrelated. Along the flood plain, high stream stages tend to recharge the ground-water system. But ground water tends to discharge to the streams during periods of low streamflow. Potential recharge has been estimated to be roughly 150,000 acre-feet a year.

However, much of the potential recharge is rejected or part returns to the streams to leave the State as streamflow. About 46,000 acre-feet of ground water is lost by evapotranspiration on the flood-plain areas.

In Nevada, development of surface water through reservoir storage is largely confined to the Owyhee and South Fork Owyhee River systems. Wild Horse Reservoir (capacity 32,690 acre-feet) is being enlarged to about 70,000 acre-feet by construction of a new dam. Smaller reservoirs, include Sheep Creek, Deep Creek, Wilson Creek, Bull Run, Rawhide, and I. L. Charleston Reservoir is on the Bruneau River. These reservoirs provide for limited storage and regulation of the streams. However, the principal reservoirs are downstream from Nevada.

To date, ground-water development by wells has been small. Several wells are used for supplemental irrigation in Independence, Salmon Falls Creek, and Goose Creek Valleys; but the annual withdrawals have been small. Two irrigation wells currently in use in Independence Valley obtain water from valley fill, two flowing wells in Goose Creek Valley apparently obtain their water from carbonate rocks, and two new wells in northern Salmon Falls Creek Valley obtain their water from volcanic or associated sedimentary rocks. The wells that tap the volcanic rocks have the largest yields--one of these reportedly flows about 1,250 gallons a minute and the other pumps about 2,500 gallons a minute. These large yields cannot be expected everywhere in the basin, but do suggest that possibilities exist.

Additional development of water in the Snake River basin in Nevada is possible, but only subject to existing water rights and agreements. On the premise of perennial-yield concept, development might salvage as much as 45,000 acre-feet of ground water a year now lost by evapotranspiration in the flood-plain areas. Most of this may be recoverable in Independence, Duck, and lower Salmon Falls Creek Valleys where ground-water losses by evapotranspiration are estimated to be about 15,000, 3,600, and 7,400 acre-feet a year, respectively. Increased pumping probably would induce greater recharge from present streamflow. This would affect streamflow but could be beneficial in providing a means of further regulation of the flow system in the basin.

The few selected chemical analyses suggest that the surface water and ground water commonly are of good quality. Most of the analyses indicate water classified as having medium salinity and low alkali hazards. Two river and two ground-water samples, analyzed for boron, indicated a concentration of 0.1 mg/l or less. Water commonly is hard. The low chemical concentrations of most of the samples analyzed is consistent with the apparently free circulation of the surface- and ground-water systems in the basin.

INTRODUCTION

Purpose and Scope of Report

Brief investigations are being made by the Geological Survey in cooperation with the Department of Conservation and Natural Resources, to provide reconnaissance information on water resources for essentially the entire State of Nevada. These reconnaissance studies were authorized by the State Legislature (Chapter 181, Statutes of 1960). The purpose was to provide ground-water resources information more rapidly as an aid and stimulus in effective development and management of water resources in Nevada. The present report is the 48th in the reconnaissance series. Figure 1 shows the areas for which reports have been published in the series and the area described in this report. The titles are listed at the end of this report.

During the course of the ground-water studies, it was recognized that there also was a deficiency of information about surface-water resources for other than the principal streams in the State. The 31st report and subsequent reports have included evaluations of surface-water resources as well as ground-water resources. Since the Snake River basin in Nevada has several large perennial streams, this report emphasizes surface-water resources more than previous reports of the reconnaissance series.

Previous Investigations

Several water-resources studies by the Geological Survey have been made of the Snake River basin or parts of it in Idaho. A number of these included the Nevada part of the basin although emphasis typically has been directed toward possible water development in Idaho. Piper included the Nevada part in his study of Goose Creek basin (1923) and Bruneau River basin (1924). Stearns, Crandall, and Stewart (1938) briefly discussed conditions in the Idaho part of Goose Creek and Salmon Falls Creek Valleys in conjunction with their overall study of geology and ground water in the Snake River Plain. The drainage area in Nevada was included in the study by Thomas, Broom, and Cummans (1963) of the magnitude and frequency of floods in the Snake River basin. Mundorff, Crosthwaite, and Kilburn (1964) briefly described ground-water conditions between the Snake River and the Nevada State line, in a study of ground water for irrigation in the Snake River basin in Idaho. More recently, Crosthwaite (written commun., 1968) is completing reports on water-resources appraisals of Salmon Falls Creek and Goose Creek basins which include consideration of the inflow from Nevada. Eakin (1962) described the ground-water resources of Independence Valley, the headwater valley of South

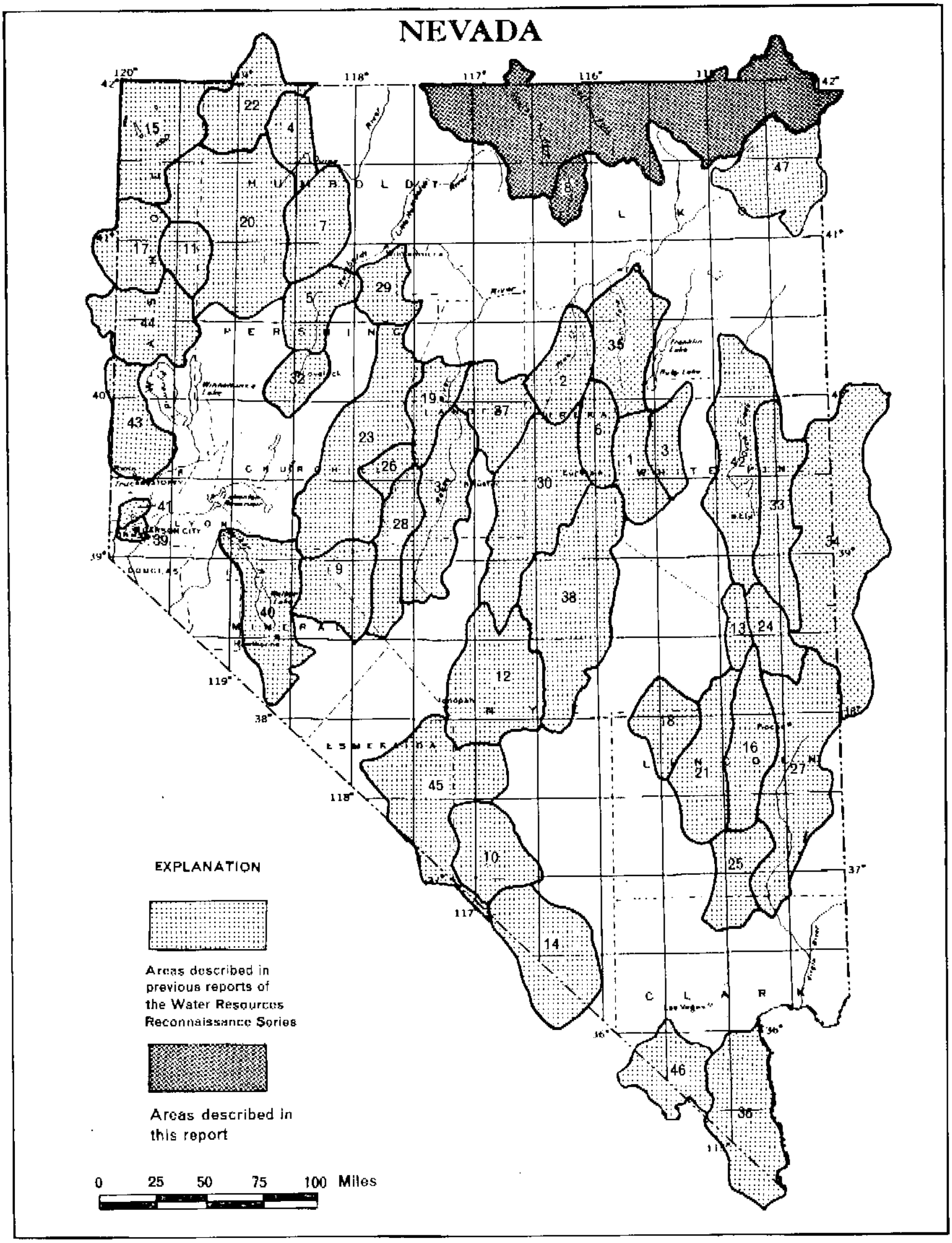


Figure 1.—Areas in Nevada described in previous reports of the Water Resources Reconnaissance Series and the area described in this report

Fork Owyhee River in one of the earlier reports of the Water Resources Reconnaissance Series. Several examinations of potential well sites for stock water have been made in parts of the Snake River basin in Nevada by Survey personnel under the soil and moisture programs. H. C. Riggs (written commun., 1968), of the Geological Survey has been investigating runoff in the Bruneau River basin.

Acknowledgments

The authors wish to express their appreciation to the Nevada Fish and Game Commission for the miscellaneous streamflow measurements which they furnished. Some well data were supplied by personnel in the Soil and Moisture Program of the Water Resources Division. The authors also wish to express their appreciation to Leo Bohner for his field assistance in making streamflow measurements and to Otis B. Purkiss for the field canvass of wells and his aid in computing some of the data in this report.

Location and General Features

The Snake River, a major tributary of the Columbia River, drains much of Idaho and parts of Washington, Oregon, Nevada, Utah, and Wyoming. This report covers the Nevada part of the Snake River basin, but with due regard to inflow from upstream tributaries in Idaho. The Snake River basin in Nevada includes an area of 5,100 square miles, enclosed by lat 41°07' and 42°00' N. and long 114°02' and 117°27' W. in the northern part of Elko County and the northeastern part of Humboldt County.

U.S. Highway 95 and Nevada State Highways 11 and 43 trend northerly through the study area. U.S. Highway 40 crosses Nevada in an east-west alinement a few miles south of the area. These roads, with other improved roads and many trails, provide access to much of the area except at times of adverse weather conditions.

The area is sparsely populated with the principal activity being cattle raising, though mining, hunting, and fishing contribute to the economy of the area. Livestock graze mainly on the range but supplemental feed is supplied from irrigated meadows. The irrigated meadow areas lie generally along the major streams with the principal irrigation being supplied by streamflow.

Hardman and Mason (1949, p. 12) show the Snake River basin in Nevada to be in parts of two growing-season zones: The Sierra zone, which occupies generally the southern and northeastern parts, and the Upper Humboldt zone, which occupies the remainder of the area.

Hardman and Mason (1949, p. 15) describe the character of the growing season of each of these two zones about as follows: The Sierra zone "consists of mountaintops and high plateaus and is characterized by low summer temperature and the possibility of frost or snow in any month of the year. Agriculture is limited to grazing and harvesting of a small acreage of mountain meadow hay."

The Upper Humboldt zone is "entirely a ranching and grazing area because of low growing season temperatures and of the hazard to tender plants of killing frosts in the summer months. Cereal grains, one crop of alfalfa, and hardy vegetables can be grown in favorable locations. Meadow hay is the major harvested crop. Large areas are devoted to native pastures."

Physiography and Drainage

Nearly all of the Snake River basin in Nevada is more than 5,000 feet above sea level. The Jarbidge Mountains and associated highlands, including the Independence and Bull Run Mountains, comprise the headwater area for the four largest streams (see pl. 1). The highest points are: Matterhorn (10,839 feet), Jarbidge Peak (10,789 feet), Marys River Peak (10,565 feet), McAfee Peak (10,439 feet), and Jack Peak (10,198 feet). The mountains are characterized by rugged relief and deep canyons.

The area to the west is a high tableland with a few coulees or canyons, as much as 600 feet deep, formed by the South Fork Owyhee River and its principal tributaries. The surface of the tableland, interrupted by low volcanic cones, generally has a poorly defined drainage with many small undrained playas. Some of the volcanic cones rise as much as 350 feet above the general tableland. The tableland is terminated on the west by the Santa Rosa Range.

The area to the east of the highlands is characterized as a mountain and valley area with well developed drainage.

All of the major streams drain into Idaho (see pl. 1). However, in the east, Goose Creek and Salmon Falls Creek originate in Idaho and flow southward into Nevada in their headwater areas. In Nevada, their courses turn eastward then north to flow back into Idaho. Shoshone Creek, a tributary of Salmon Falls Creek, also drains an area in Idaho. The Bruneau and Jarbidge Rivers generally drain northward throughout their courses. The Owyhee and South Fork Owyhee Rivers have a strong northwest component to their courses in Nevada. Thus, the major streams flow radially from the principal runoff area of the Jarbidge Mountains and related highlands.

The streams are deeply incised in most of the basin. This results in relatively narrow flood plains which minimize the areas of evapotranspiration of ground water and streamflow. Further, the general gradient of the streams are steep. Even the lowest flood-plain gradient is 14 feet per mile, as is shown in the following tabulation.

Stream	Section	Flood-plain gradient ft/mi
Goose Creek	Below Little Goose Creek	17
Salmon Falls Creek	North from San Jacinto Ranch	16.7
Jarbidge	North from Jarbidge	90
Bruneau	Discharge area; near Charleston	17
Bruneau	North from Mink Ranch	37
Owyhee	Near Wild Horse Crossing	67
Owyhee	Discharge area; near Owyhee	16
South Fork Owyhee	Discharge area; Independence Valley	18
Bull Run Creek	Irrigated area	24
South Fork Owyhee	Discharge area; near Bull Run Creek	14
South Fork Owyhee	Northwest from Chimney Creek	16.7

PRECIPITATION

Precipitation varies widely from one part of the area to another. The western tableland of the study area is semiarid, whereas the eastern part approaches humid conditions and the central high mountain part approaches a subalpine climate. The distribution of precipitation is related to the topography, with the areas at high altitudes receiving more precipitation than those at low altitudes. Precipitation in the high mountains consists largely of winter snow and a lesser amount of rain from local summer storms. In the lower areas much of the summer precipitation is from thunderstorms.

Precipitation data have been recorded at several stations in and close to the study area. The records are published by the United States Weather Bureau in monthly and annual summaries and are not repeated here. One of the longest records is at Tuscarora, where records have been obtained for several periods from 1889 to date. Table 1 summarizes the average monthly and yearly figures for several of the precipitation stations. Locations of the stations are shown in figure 2.

Precipitation varies with the season and with locality. Monthly precipitation statistics for Tuscarora, Jarbidge, Owyhee, and Montello are summarized graphically in figure 3 to demonstrate these variations. Jarbidge has the greatest precipitation and Montello the least.

Figure 4 shows the cumulative departure curves for Jarbidge, Owyhee, and Montello. These graphs indicate that the variations from year to year respond to wet and dry intervals. Years of above average precipitation have an upward trend and years of below average precipitation have a downward trend. A drought can occur in one part of the area and not in another. For example, Jarbidge had below average precipitation from 1939 to 1944, except for 1943 which was near average, whereas precipitation at Montello was well above average in 1940 and 1944 and Owyhee well above average in 1940 and 1941 and slightly above in 1944. In addition to variations in precipitation from year to year and seasonally within the year, localized storms give rise to short-term variations.

In addition to the record of precipitation, 15 snow courses are operated within the study area and several more nearby. These courses are indicative of precipitation at the higher altitudes where recording or storage precipitation stations are scarce. Table 2 summarizes the April 1 and May 1 water content at three snow courses on Jack Creek. The change in altitude between the lower Jack Creek station and Jacks Peak is only 1,620 feet, but the average April 1 water content at Jacks Peak course is about 7 times that of the lower station. Also, the snowmelt runs off much

Table 1.--Summary of precipitation in and adjacent to the Snake River basin

[From published records of the U.S. Weather Bureau]

Station name	Altitude	Period of record used	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Contact	5,365	1948-65	0.84	0.59	0.63	0.73	1.71	1.20	0.38	0.71	0.50	0.51	0.69	0.84	9.28
Coon Creek Summit	8,300	1953-62	(Storage gage)												32.30
Gance Creek	6,360	1950-58;1960	(Storage gage)												11.34
Gold Creek	6,600	1914-30	1.66	1.57	.92	1.31	1.07	1.03	.36	.54	.80	1.25	1.17	1.45	13.18
I. L. Ranch	5,200	1963-65	1.15	.50	.63	1.96	2.96	3.51	.25	.49	.88	1.03	1.05	1.43	15.66
Jacks Creek Pass	7,725	1948-62	(Storage gage)												32.00
Jarbidge	6,200	1918;1921-29; 1933;1939-60	2.30	1.97	2.17	2.43	2.26	1.73	.52	.56	.90	1.58	1.61	2.07	20.04
Montello	4,877	1877-1960	.55	.46	.31	.54	.76	.65	.36	.37	.37	.47	.44	.54	5.82
Mountain City R.S.	5,620	1956-64	1.34	1.26	1.15	.93	1.72	1.59	.25	.48	.69	.83	1.19	1.44	12.86
Owyhee	5,396	1900-01;1924; 1933-34;1939-64	1.37	1.26	1.34	1.38	1.92	1.40	.29	.30	.57	1.24	1.18	1.43	13.28
San Jacinto	5,200	1904-30;1932-34; 1936-42;1944; 1946-47	.66	.52	.60	.95	1.21	1.04	.53	.46	.55	.66	.61	.55	8.44
Saval Ranch	6,360	1961-64	1.02	1.05	.82	.75	1.72	1.92	.20	.57	.44	1.07	1.00	1.63	12.18
Stofiel	7,000	1893-95	3.22	3.27	3.81	1.97	1.24	.42	.42	.46	1.04	.39	1.21	2.57	20.01
Tuscarora	6,175	1889;1896; 1898-99;1919-36; 1939-64	1.54	1.29	1.39	1.33	1.60	1.12	.32	.43	.54	1.12	1.27	1.61	13.54

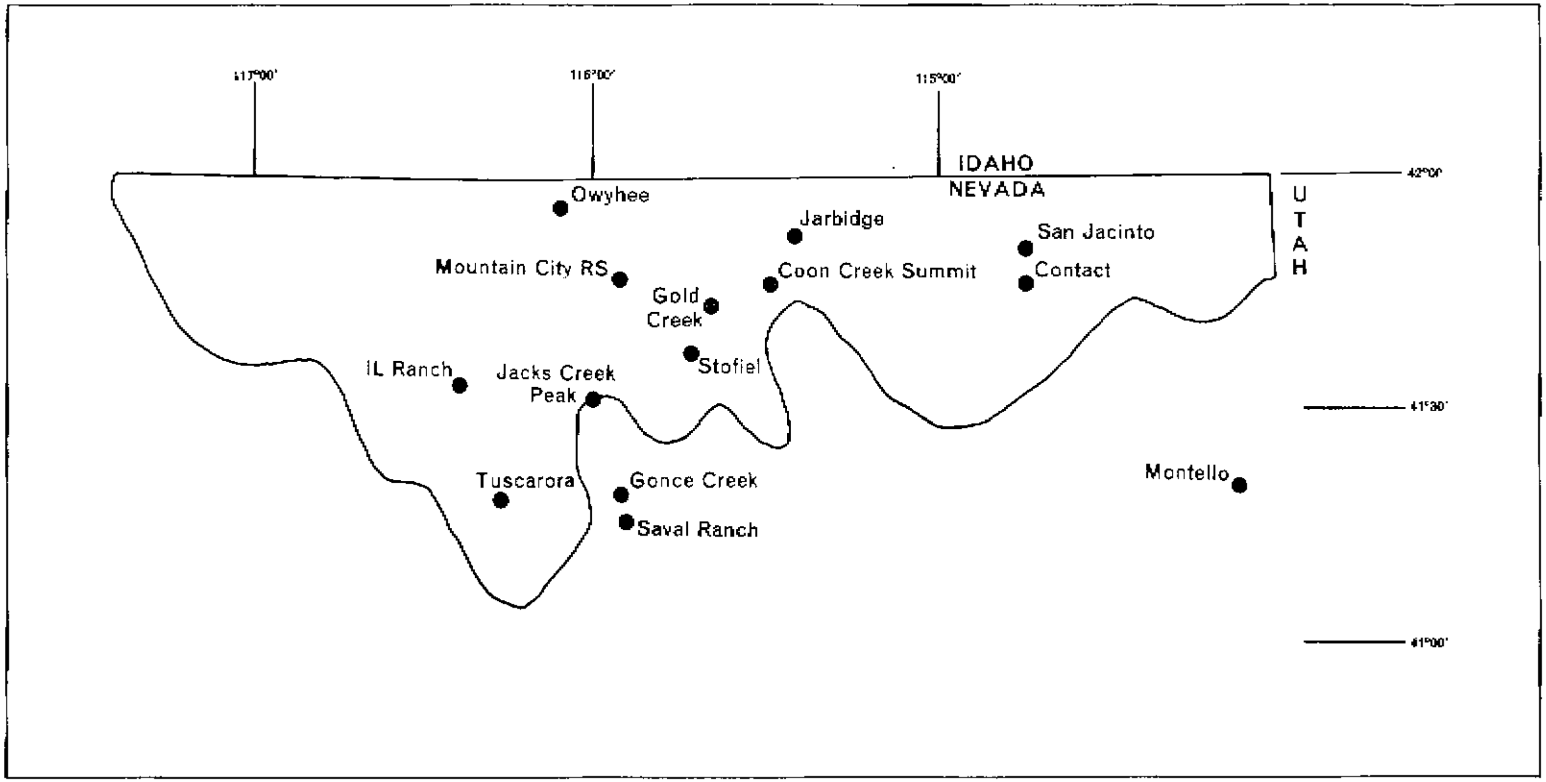


Figure 2.— Map showing general locations of precipitation and temperature gages.

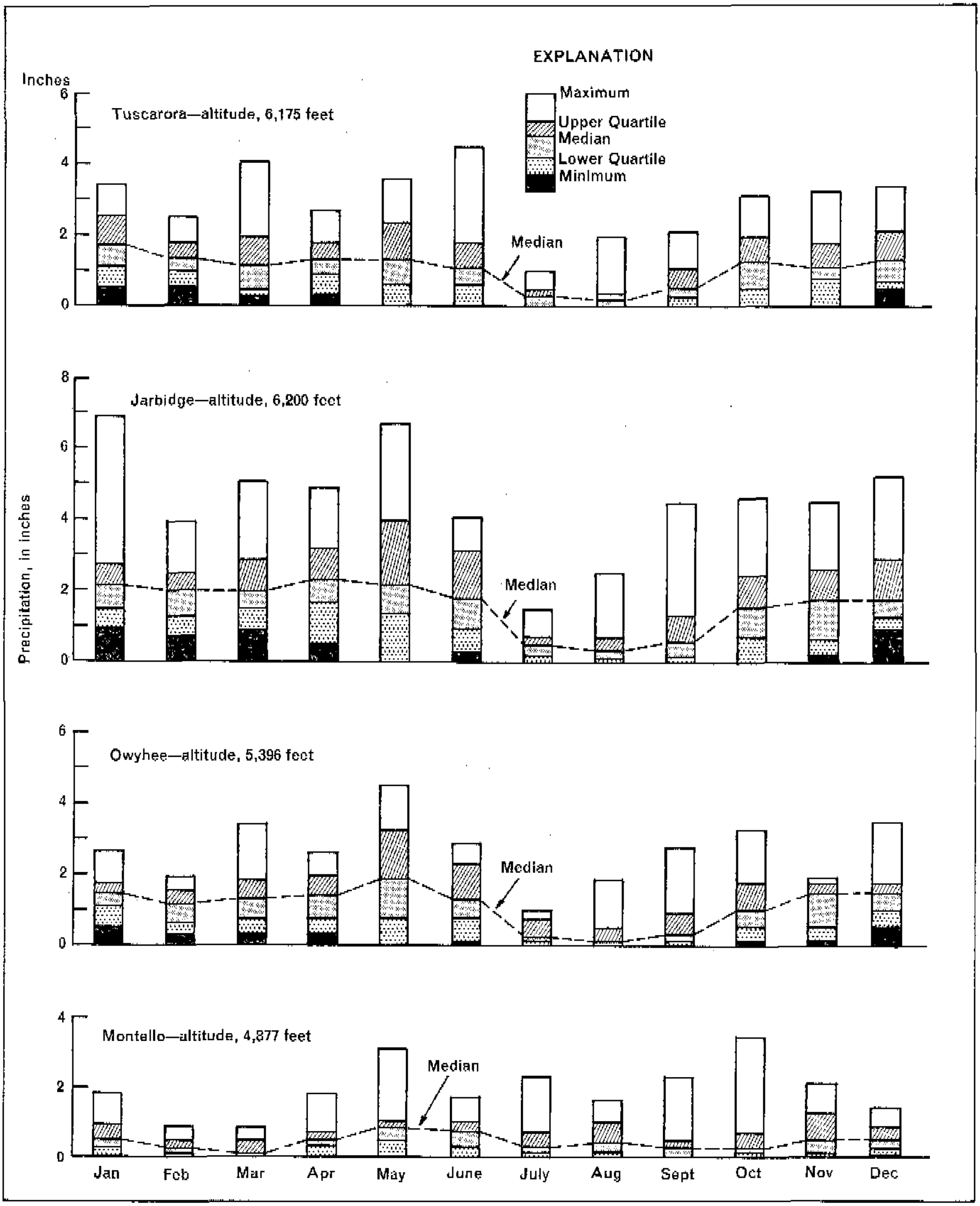


Figure 3.—Distribution of precipitation by months at Tuscarora, Jarbidge, Owyhee, and Montello, Nevada for the period 1939-60.

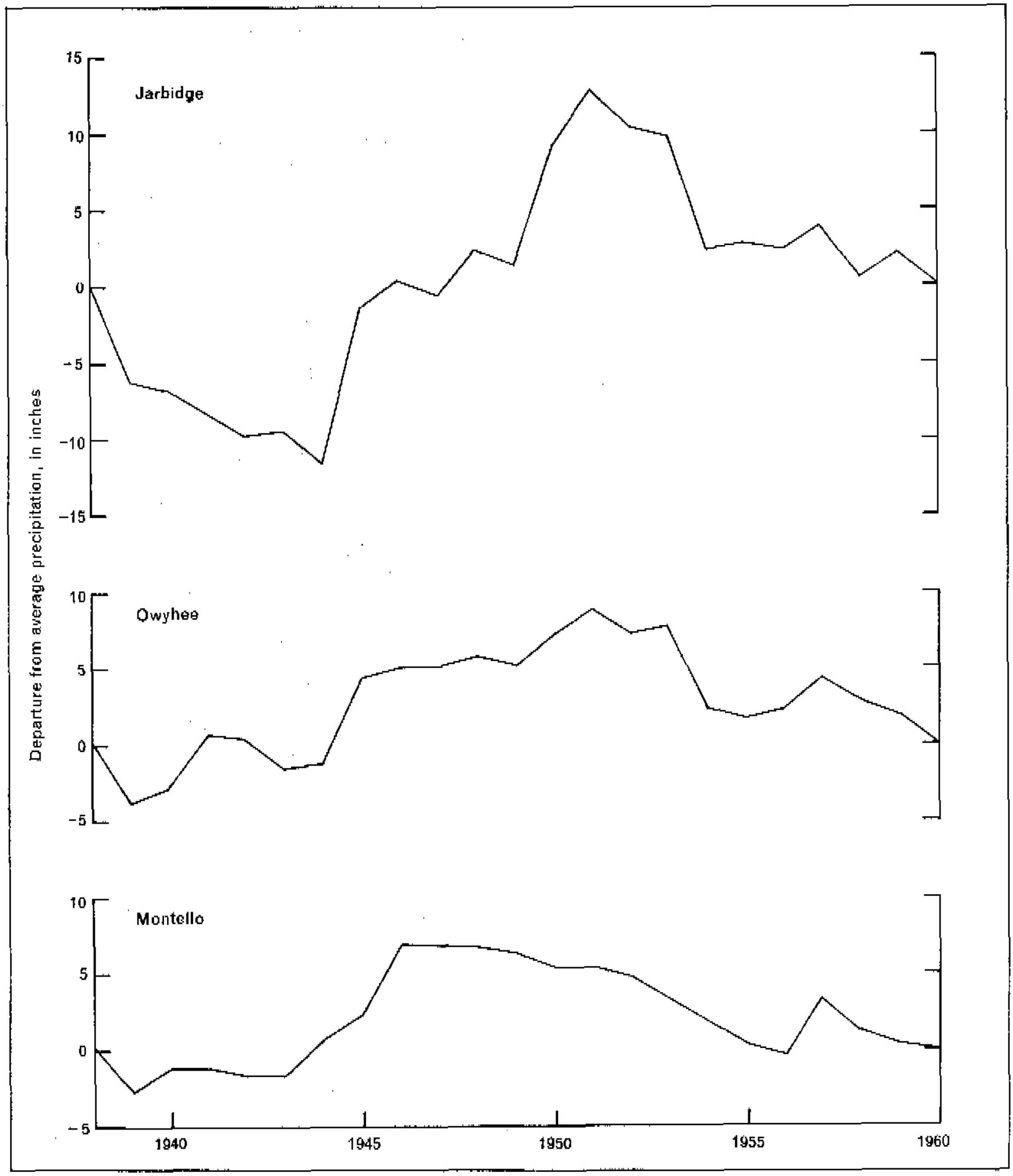


Figure 4.—Cumulative departure curves for average precipitation at Jarbidge, Owyhee, and Montello, Nevada for the period 1939-60.

Table 2.--Average water content on April 1 and May 1 for snow courses in Jack Creek basin for period 1957-61

Snow course	Altitude	Inches of water	
		April 1	May 1
Lower Jack Creek	6,800	4.2	0
Upper Jack Creek	7,250	12.0	4.9
Jacks Peak	8,420	28.1	29.6

earlier at the lower altitudes than at the higher altitudes. For example, the average water content decreased substantially at lower and upper Jack Creek snow courses between April 1 and May 1 but increased at Jacks Peak snow course during the same period.

Precipitation tends to increase with altitude, but this relation varies greatly in detail. Thomas and others (1963, pl. 2) prepared an isohyetal map of the area as a part of the larger drainage area of the Snake River; it shows the general distribution of precipitation. However, for the purpose of this report, a relation of precipitation to altitude zones was defined for simplified computation. The two maps result in a somewhat different distribution of indicated precipitation but are in reasonable agreement with average precipitation values for areas that could readily be compared.

Figure 5 is a plot of precipitation versus altitude for the stations listed in table 1. Line "a" is fitted visually to the plotted points. However, six stations have a narrow range in precipitation between 11.34 to 13.54 inches, although the altitude ranges from 5,400 to 6,600 feet. Line "b" is shifted parallel to line "a" so as to pass through the mean value for the six stations, and the following approximate relation of precipitation to altitude is obtained:

Altitude zone (feet)	Average precipitation (inches)
5,000-6,000	8.3
6,000-7,000	16.5
7,000-8,000	24.8
8,000-9,000	33
>9,000	40

These values are only roughly representative as no adjustment has been made for different lengths of records. Further, the distribution and small number of stations for the size of the area make it unlikely that they would produce highly accurate representation of the regional relation. Nevertheless, the values provide a means for indicating the general magnitude of precipitation in the region. Table 3 gives the estimated average annual precipitation by altitude increments for the Nevada part of the several valleys in the Snake River basin. For the area in Nevada, the indicated average annual precipitation is 14.4 inches, which equals a volume of about 3.9 million acre-feet for the total area.

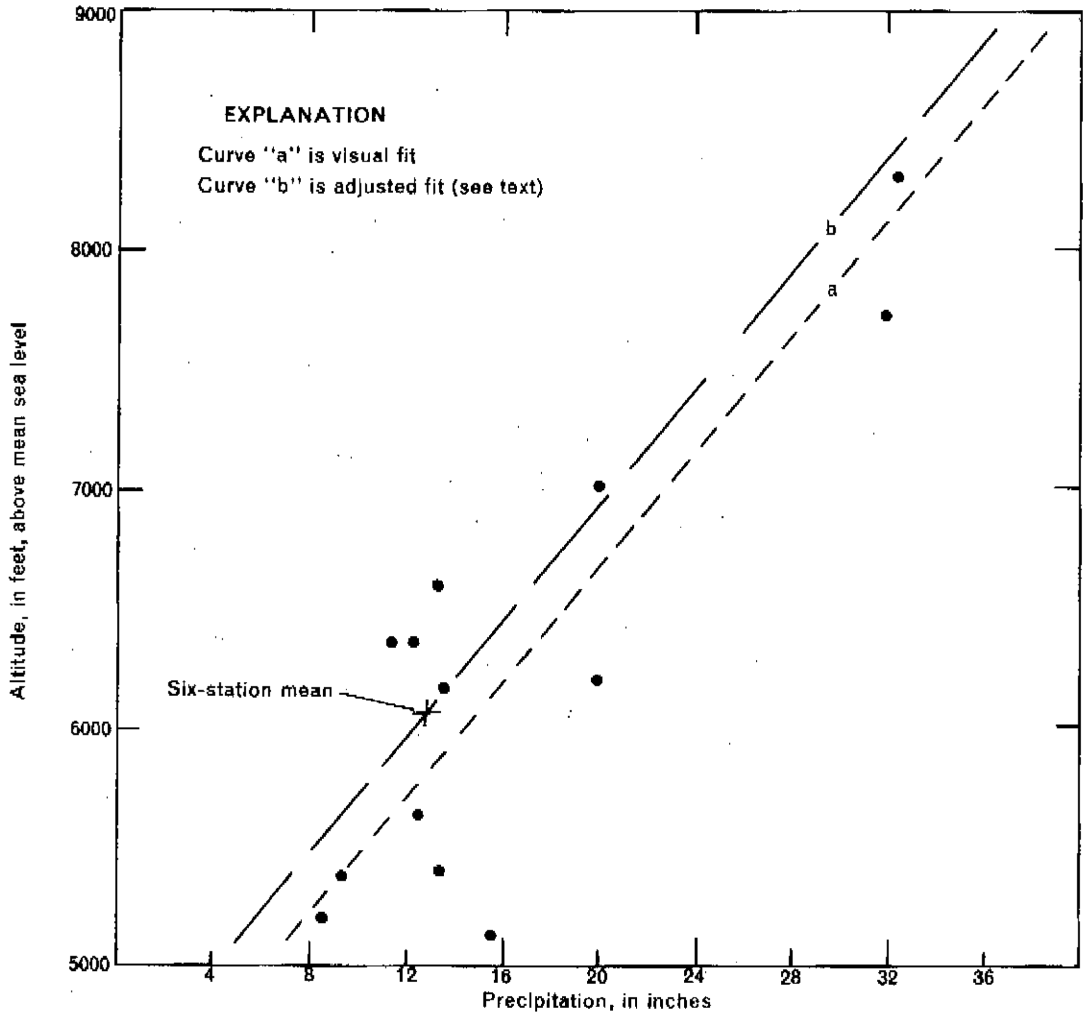


Figure 5.—Graphs of approximate relation of precipitation to altitude in Snake River Basin in Nevada

Table 3.--Estimated average annual precipitation for the Snake River basin in Nevada

(Values significant to no more than two figures)

Valley	Altitude zone (feet)	Area of zone (1,000's acres)	Estimated average annual precipitation: Feet	Estimated average annual precipitation: Acre-feet (1,000's)	Weighted average (inches)
Goose Creek	>7,000	5	2.0	10	
	6,000-7,000	70	1.4	98	
	<6,000	129	.7	90	
Subtotal		204		198	11.7
Salmon Falls Creek					
Upper area	>9,000	2.9	3.3	9.6	
	8,000-9,000	20	2.8	56	
	7,000-8,000	48	2.0	96	
	6,000-7,000	157	1.4	220	
	<6,000	22	.7	15	
Subtotal		250		397	19.1
Jakes Creek area	>8,000	1.8	2.8	5	
	7,000-8,000	28	2.0	56	
	6,000-7,000	90	1.4	126	
	<6,000	64	.7	45	
Subtotal		184		232	15.1
Lower area	>8,000	1.2	2.8	3.4	
	7,000-8,000	26	2.0	52	
	6,000-7,000	131	1.4	183	
	<6,000	127	.7	89	
Subtotal		285		327	13.8
Cottonwood Creek area	>7,000	4.2	2.0	8.4	
	6,000-7,000	33	1.4	46	
	<6,000	15	.7	11	
Subtotal		52		65	15
Salmon Falls Creek Total		771		1,021	15.9
Bruneau River	>9,000	1.7	3.3	5.6	
	8,000-9,000	13	2.8	36	
	7,000-8,000	75	2.0	150	
	6,000-7,000	200	1.4	280	
	<6,000	36	.7	25	
Subtotal		326		497	18.3

Table 3.--Continued

Valley	Altitude zone (feet)	Area of zone (1,000's acres)	Estimated average annual precipitation: Feet	Estimated average annual precipitation: Acre-feet (1,000's)	Weighted average (inches)
Jarbidge River	>9,000	11	3.3	36	
	8,000-9,000	28	2.8	78	
	7,000-8,000	58	2.0	116	
	6,000-7,000	72	1.4	101	
	<6,000	4.9	.7	3.4	
Subtotal		174		334	23
Owyhee River	>8,000	3.9	2.8	11	
	7,000-8,000	60	2.0	120	
	6,000-7,000	200	1.4	280	
	<6,000	67	.7	47	
Subtotal		331		458	16.6
South Fork Owyhee Upstream from Red Cow Creek	>9,000	1.7	3.3	5.6	
	8,000-9,000	9.3	2.8	26	
	7,000-8,000	54	2.0	108	
	6,000-7,000	174	1.4	244	
	<6,000	81	.7	57	
Subtotal		320		441	16.5
Deep and Bull Run Creeks area	>8,000	4.9	2.8	14	
	7,000-8,000	26	2.0	52	
	6,000-7,000	56	1.4	78	
Subtotal		87		144	19.9
Remaining area	≤6,000	599	.7	419	8.4
South Fork Owyhee Total		1,006		1,004	12.0
East Little Owyhee	>7,000	4	2.0	8	
	6,000-7,000	49	1.4	69	
	<6,000	400	.7	280	
Subtotal		453		357	9.4
Snake River basin Nevada part (rounded)		3,260		3,900	14.4

EVAPOTRANSPIRATION

Most of the water supplied to the Snake River basin in Nevada is removed from the area by evaporation and transpiration. Kohler, Nordenson, and Baker (1959, pl. 2) indicate that annual lake evaporation is on the order of 40 inches for most of the Nevada part of the Snake River basin. Thornthwaite (1948, fig. 3) suggests that potential annual evapotranspiration generally ranges from about 18 to 24 inches for the same area. Thus, on an annual basis the potential for removal of water from the basin by evapotranspiration is significantly greater than the indicated average annual precipitation of about 14 inches.

Evaporation and transpiration vary seasonally and rates are greatest in the summer and least during the winter months. Temperature records, which in part show the seasonal trend of evapotranspiration, are obtained at several stations in or near the study area. Monthly and annual ranges of temperature for Jarbidge and Owyhee are graphically illustrated in figure 6. Evapotranspiration rates vary with vegetation and in response to available water, cloud cover, wind velocity, temperature, humidity, soil, and topographic parameters. As these show substantial variation within the basin, actual evapotranspiration should vary in different parts of the basin.

Preliminary estimates suggest that more than 80 percent of the precipitation is lost by evapotranspiration about where it falls, either immediately or after a seasonal period of storage as soil moisture, snow, or in lakes or reservoirs. Of the water that becomes runoff or ground water, part of it subsequently is lost by evapotranspiration within the basin. Thus, evapotranspiration imposes a continuing though varying demand on the water that falls in the basin. Water in excess of that demand is available as runoff and ground-water underflow from the basin.

Evapotranspiration of runoff and ground water occurs largely in the lowlands of the valleys, including the flood plains of the principal streams. Table 4 summarizes the estimated evapotranspiration losses from surface and ground water in these lowland areas by principal drainage units. Losses from surface water average about 97,000 acre-feet, and from ground water average about 46,000 acre-feet a year. However, additional evapotranspiration of surface and ground water occurs in the mountain areas. Estimates of these losses are not included, however, because estimated runoff generally allows for the evapotranspiration losses from these areas.

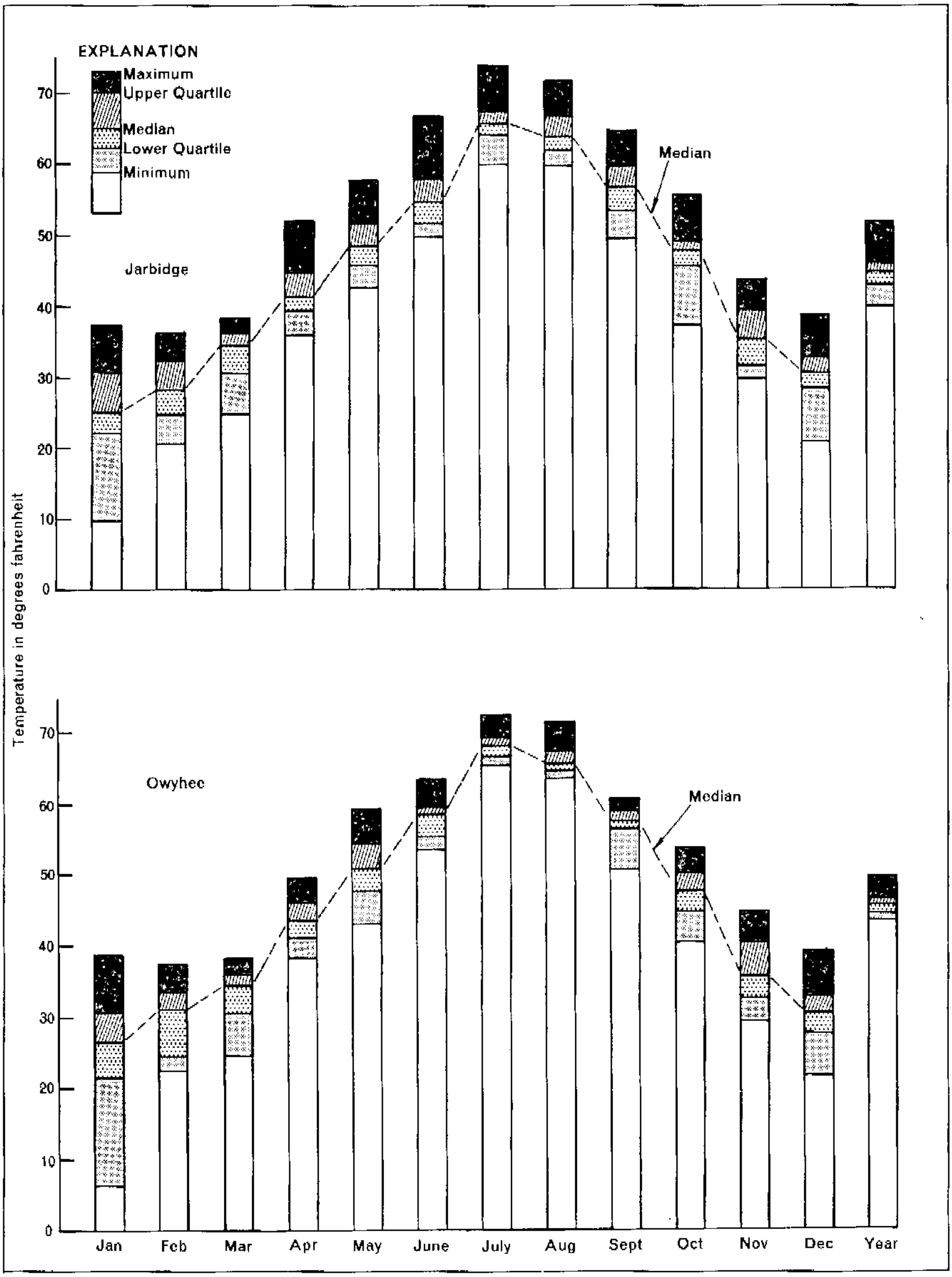


Figure 6.—Distribution by months and year of temperature at Owyhee and Jarbidge, Nevada 1939-60.

Table 4.--Estimated average annual losses by evapotranspiration from surface water and ground water in the lowlands of the Snake River basin in Nevada

(Values significant to not more than two figures)

Basin	Principal lowland areas of ground-water discharge (acres)1/	Evapotranspiration losses (acre-feet per year)						
		Wet, semiwet, or irrigated areas			Other shallow ground-water areas			
		Surface water2/	Ground water3/	Sum	Surface water4/	Ground water5/	Sum	Combined losses
Goose Creek	2,000 6/	2,500	1,000	3,500	--	--	--	4,700
	1,840 7/	--	--	--	460	740	1,200	
Salmon Falls Creek								
Upper 8/	5,420 6/	6,780	2,710	9,490	--	--	--	
Lower 9/	9,750 10/	12 200	4,880	17,080	--	--	--	30,660
	6,330 7/	--	--	--	1,560	2,530	4,090	
Bruneau and Jarbidge Rivers 11/	4,070 6/	5,120	2,040	7,160	--	--	--	9,110
	3,000 7/	--	--	--	750	1,200	1,950	
Owyhee River								
Upper 12/	6,900 6/	8,625	3,450	12,075	--	--	--	24,675
Duck Valley	7,200 6/	9,000	3,600	12,600	--	--	--	
South Fork Owyhee River								
Independence Valley 13/	23,600 6/	29,500	11,800	41,300	--	--	--	
	7,800 7/	--	--	--	1,950	3,100	5,050	73,395
Other	14,200 6/	17,800	7,100	24,900	--	--	--	
	3,300 7/	--	--	--	825	1,320	2,145	
East Little Owyhee River	Negligible							
Total drainage area	95,400	91,500	36,600	128,100	5,500	8,900	14,400	142,500

See footnotes on following page.

Footnotes to table 4.

1. Principally lowland of valley areas, but includes some of the larger lowland segments in the mountain areas; partly adapted from Houston and Naphan (1952).

2. Evapotranspiration from surface-water sources estimated to average about 1.0 foot plus 0.25 foot evaporation from excess water; all lowlands subject to inundation.

3. Evapotranspiration from ground-water sources estimated to average about 0.5 foot due to shallow water table commonly associated with these areas; ground water used as surface-water supplies diminish.

4. Evapotranspiration from surface-water sources assumed to average about 0.25 foot to represent losses from periodic flooding of parts of these areas.

5. Evapotranspiration from ground-water sources estimated to average about 0.4 foot in those areas where depth to water averages about 10 feet or less.

6. Mainly irrigated wetland and willow areas.

7. Vegetation generally characterized by big sage, greasewood, or rabbitbrush.

8. Area upstream from badlands.

9. Area downstream from badlands.

10. As footnote 7 but includes saltgrass meadows.

11. Areas essentially for Bruneau River area; Jarbidge area is small.

12. Area upstream from China diversion.

13. Area downstream from China diversion.

GROUND WATER

Hydrogeology

The rocks that crop out in the Nevada part of the Snake River basin are predominantly of Cenozoic age. Cenozoic volcanic and sedimentary rocks occupy about 85 percent of the total area of the basin. Paleozoic sedimentary and intrusive rocks are predominant in the remaining area and are extensively exposed in the mountains, but locally occur in the lowlands, such as near Contact and San Jacinto in Salmon Falls Creek Valley and south of Trout Creek Ranch in Goose Creek Valley. The general distribution of rock types is shown on plate 1.

The intrusive rocks are the least permeable of the rocks in the area. Locally, weathered or fractured parts of the intrusive rocks may transmit limited quantities of water. However, this characteristic generally is limited to within a few hundred feet of land surface.

Consolidated, cemented, or metamorphosed sandstone or shale, largely of Paleozoic age, has very low permeability but fractured parts often provide a secondary permeability through which limited amounts of water may be transmitted. The fractures usually are more open within 200 or 300 feet of land surface and thus much of the water would move in this zone. Water from these rocks supply some seeps, small springs, and streams in the mountains.

Paleozoic carbonate rocks locally may transmit significant quantities of water through fractures or solution openings, although the unfractured carbonate rocks have low permeability. Springs a half mile south of the San Jacinto Ranch in Salmon Falls Creek Valley and near the Trout Creek Ranch in Goose Creek Valley appear to be closely associated with carbonate rocks.

Cenozoic (Tertiary) volcanic and associated sedimentary rocks have a wide range in capacity to transmit water. Fine-grained tuff generally yields water very slowly but fractured welded tuff locally transmits water freely. Scoriaceous or broken tops and bottoms of lava flows may prove excellent aquifers where saturated. This has been amply demonstrated in the parts of the Snake River Plain in Idaho, but has not yet been thoroughly tested in the Nevada part of the Snake River basin. The associated sedimentary deposits commonly are relatively fine grained and tend to have low permeability. However, gravel, such as the Banbury Formation in the Jarbidge drainage near the State line (Coats, 1964) could yield water freely where saturated. The wide extent of the Tertiary volcanic and associated deposits suggest that the saturated parts store large quantities of water.

Quaternary sediments have been laid down as stream and alluvial-fan deposits in the principal valleys. However, as the area has been one of exterior drainage during most of Quaternary time, these deposits generally are less than perhaps 100 feet thick.

Sand and gravel units of these deposits have moderate to high permeability. Commonly, sand and gravel units underlie the flood plains but occur locally also in other parts of the valley fill, such as Independence Valley.

The fine-grained units of the Quaternary deposits have low permeability. The low permeability may impede water movement, locally control the occurrence of small springs, and sustain small bodies of perched ground water. Where saturated, they may store considerable quantities of ground water.

On plate 1 the grouping of the rocks emphasizes the general distribution. In actuality, small areas of unconsolidated deposits occur within the consolidated-rock areas and consolidated rocks may locally crop out within the areas mapped as unconsolidated deposits.

The distribution of the various rocks affects runoff and streamflow. Other things being equal, highly permeable rocks have high infiltration rates and generally small local runoff, whereas rocks of low permeability tend to facilitate runoff.

Occurrence

Ground water commonly is at or near land surface in the axes of the valleys along the flood plains of the principal streams. The water table slopes upward toward the adjacent mountains but ordinarily with a somewhat lower gradient than the overlying land surface. In areas where recharge is very small, such as in the area west of the South Fork Owyhee River, the gradient may be very flat indeed.

Ground water occurs in the porous valley-fill and associated Tertiary volcanic and sedimentary deposits, forming a continuous area of saturation. It also fills fractures in the other consolidated rocks beneath the valleys. Ground water in the consolidated rocks in the mountains commonly does not form a continuous body throughout the range; rather, local barriers caused by faults or rocks of low permeability produce a complex pattern of perched and semiperched ground-water bodies. Ground-water bodies of this type commonly supply water for numerous mountain springs and supply much of the late-season flow of the mountain streams.

Movement

Ground water moves from areas of recharge to areas of discharge; that is, in the direction of lower potential hydraulic head. The flood plains, which are the areas of principal ground-water discharge, have a gradient down the axes of the valleys. The general movement of ground water reflects this feature whereby water-level contours, lines of equal altitude, are roughly U-shaped or concave downstream. The base of the "U" is controlled by the altitude of the stream and flood plain. Thus, general movement is from the mountains toward the valley axis and with a downstream component in response to the gradient of the flood plain. The above primarily reflects the lateral component of ground-water movement. The associated vertical component of ground-water movement can be characterized as steeply downward in areas of recharge and steeply upward in areas of natural discharge.

The principal streams in the basin function as ground-water drains. Most of the ground water not removed by evapotranspiration in the adjacent flood plains reaches the stream and leaves the areas as streamflow. Thus, the low flow of the principal streams is largely supported by ground-water discharge either through springs or by seepage.

Significant local variations of ground-water movement from the general pattern do occur. The principal areas of ground-water discharge are the flood plains. However, during high stages of the streams and accompanying inundation of the flood plains, gradients temporarily are reversed and movement from the stream to the ground-water system occurs. As the stage of the stream lowers and ground-water recharge terminates, the ground-water gradients return to normal and ground-water movement toward the stream resumes. The movement resulting from alternating recharge and discharge in the flood plains requires at least some seasonal fluctuations of water levels in these areas. Although continuing water-level records are not available, physical conditions indicate that fluctuations generally would range within a few feet of the average water levels.

Storage

The total amount of ground water in storage cannot be determined absolutely, as the physical properties and specific limits of the water-bearing and water-yielding rocks are not known. However, within the approximately 5,000-square-mile drainage area in Nevada, ground water stored in only the upper 100 feet of saturated rocks probably exceeds 15 million acre-feet. Undoubtedly, much of the water in this zone would not be economically recoverable or locally might not be chemically suitable for particular uses.

More restricted illustrations might be more useful for comparative purposes. The Salmon Falls Creek Valley downstream from Contact, contains at least 10,000 acres in the lowland area. If it is assumed that the upper 100 feet of saturated Quaternary and Tertiary deposits beneath the 10,000-acre area will yield 10 percent of their volume, then the amount of ground water stored in this volume of deposits is 100,000 acre-feet. This quantity is about 55 percent of the usable capacity of the Salmon River Canal Company Reservoir.

Similar assumptions applied to a 7,200-acre area of the lowlands of Duck Valley adjacent to the Owyhee River suggest that about 72,000 acre-feet of ground water are stored in the upper 100 feet of saturated deposits. This quantity is equivalent to the design capacity of Wild Horse Reservoir, after the completion of the new dam.

Independence Valley, drained by the South Fork Owyhee River, may be used as a final example. The area of valley fill below the 5,800-foot contour is approximately 25,000 acres. Using the same assumptions as in the previous examples, the estimated ground water stored in the saturated upper 100 feet of valley fill is about 250,000 acre-feet.

The above examples are for areas along and adjacent to parts of the flood plains subject to natural ground-water discharge and recharge. Thus, natural variations in seasonal or year-to-year ground-water storage are relatively pronounced. Even with these dynamic conditions, year-to-year natural changes in storage beneath the principal flood plains probably do not represent more than a small percentage of the volume of ground water stored in the upper 100 feet of saturated deposits beneath the flood plains; that is, not more than a few tens of thousands of acre-feet.

Recharge

Most recharge to the ground-water systems in the Snake River basin in Nevada is derived from precipitation within that basin, including that part of the area in Idaho which drains to Nevada. Precipitation may infiltrate directly to the ground-water reservoir, may accumulate as snow and then infiltrate to the ground-water reservoir, or may become overland runoff or streamflow and then infiltrate to the ground-water reservoir.

The distribution of precipitation is significant in determining where recharge may occur. Thus, the areas of greatest average precipitation tend to be the areas of greatest potential recharge. Whether or not recharge does occur then depends on the infiltration characteristics of the rocks in these areas. If the rocks are relatively permeable, recharge occurs, but if they are impermeable, excess water will leave the area as streamflow. For a given permeability more recharge can result if the land-surface gradient is low than if the gradient is high. That is, steep slopes favor runoff over infiltration, other things being equal. Runoff subsequently may flow over permeable materials and then infiltrate to the ground-water reservoir. The effectiveness of this manner of recharge is increased by overbank flooding and diversions for irrigation.

Recharge in the basin occurs both as infiltration in the mountains and infiltration from streamflow along the flood plains in the lowlands. However, the generally steep gradients in the mountains and the flood plains of the perennial streams results in much of the potential recharge being diverted to streamflow.

An empirical method has been used to estimate ground-water recharge (Eakin and others, 1951). It is assumed that precipitation generally increases with altitude, the proportion of recharge increases with precipitation, and that the lowest zone of effective precipitation generally occurs in the middle to upper segments of the alluvial apron or the equivalent altitude zone. For this area, the lower effective zone is taken to be about equivalent to the 6,000 to 7,000-foot zone with successively higher zones in 1,000-foot increments. The percentages of recharge assumed for the successive zones are 3, 7, 15, and 25. Using the areas and average precipitation estimated in table 3 potential recharge to no more than two significant figures, for the several valley units is:

		Acre-feet
Goose Creek Valley, including the Idaho drainage area		6,700
Salmon Falls Creek Valley,		
Upper Area	24,000	
Jakes Creek area	8,500	
Lower area	9,600	
Cottonwood Creek area	2,000	
Total		44,000
Bruneau River Valley and its tributaries		26,000
Jarbidge and its tributaries		32,000

		Acre-feet
Owyhee River Valley		17,000
South Fork Owyhee River Valley		
Upstream from Red Cow Creek including Independence Valley	20,000	
Deep and Bull Run Creeks headwaters	8,100	
Remaining area	small	
Total		28,000
East Little Owyhee River Valley		2,700
Snake River basin in Nevada (total, rounded)		160,000

On this basis the estimated average annual recharge to ground water in the Snake River basin in Nevada is on the order of 160,000 acre-feet. Because of relatively steep stream gradients and high unit runoff, the estimated recharge is considered as potential recharge, rather than actual. That is, some or a considerable part of the potential recharge may leave the area as streamflow without ever entering the ground-water system.

In part, this is due to the fact that during part of the year infiltration rates are exceeded and the water moves off overland. However, this also is due in part to the fact that the ground-water system locally is full with respect to the adjacent streams and therefore it rejects water that otherwise would enter the system. Such rejected water must then pass on as streamflow or be lost by evapotranspiration.

Because of these features, information from this study is insufficient to permit a direct estimate of the actual average recharge to the ground-water system in the area of this report. However, it is concluded that actual recharge is less than the potential recharge.

Discharge

Ground water is discharged from the Nevada part of the Snake River basin largely by evapotranspiration within the basin and by discharge to the perennial streams and thence out of the State as outflow. Some ground water also leaves the State as underflow. For the most part, ground-water discharge by evapotranspiration occurs in the flood plain of the principal streams and their tributaries, as shown on plate 1. Some ground water also is lost by evapotranspiration from spring or seep areas in the mountains. Discharge also occurs in areas adjacent to the flood plain where the ground water is relatively shallow, such as locally in Independence Valley and in parts of the lower Salmon Falls Creek Valley. However, the generally deep incision of the principal streams below the level of the valleys tends to limit evapotranspiration of both surface and ground water to the flood-plain segments of the stream systems. Table 4 indicates that evapotranspiration from ground water in the lowlands is on the order of 46,000 acre-feet a year. Of this amount, about one-third is discharged from the upstream segment of the South Fork Owyhee River, principally in Independence Valley. Roughly 18 percent of the total is discharged from other lowland segments of the South Fork Owyhee River and about 16 percent is lost from the lower Salmon Falls Creek area.

The amount of ground water contributed to the streamflow leaving Nevada cannot be determined precisely from available data. However, consideration of existing streamflow data in relation to the general ground-water conditions suggest that the ground-water contribution by spring discharge, seepage, and return flow, may be on the order of 10 percent, or roughly 50,000 acre-feet, of the estimated total streamflow leaving Nevada.

Even fewer control data are available by which to estimate the quantity of ground water in the Snake River basin that leaves Nevada by underflow. On the basis of the general geology, topography, and hydrology, the drainage area of the Bruneau River westward from Elk Mountain probably is the most favorable to conduct ground-water underflow northward from Nevada and even there the quantity probably is limited. In the Goose Creek Valley, topographic and hydraulic highs northwest and southeast of Goose Creek, at the State line, probably restrict ground-water outflow from the valley to a small cross section of flood-plain deposits, and consequently the annual quantity of underflow probably is small.

The shallow ground water along Salmon Falls Creek near the mouth of Shoshone Creek implies that underflow from that area is impeded significantly, most probably by a north-trending fault along the east side of the hills and west of U.S. Highway 93. Similarly in Duck Valley, north-trending faults along the west side of the valley near the State line in part are the cause of the shallow ground-water area in the valley. The Idaho part of Duck Valley drains southward to Owyhee River. A few miles north of the Nevada State line, the Owyhee River turns westerly to pass around the south side of the Owyhee Mountains and joins the South Fork Owyhee River. Thus, ground-water flow northward from the confluence of Blue Creek and Owyhee River is unlikely. However, flow potentially may be westward from the Duck Valley area parallel to the Owyhee River and the State line.

In the area west of the South Fork Owyhee River--largely the East Little Owyhee River drainage--the lateral direction of ground-water flow probably is northeasterly, based on general streamflow relationships. The apparently minor recharge and low water-level gradients suggest that the average ground-water underflow across the State line in that area probably is small.

As noted previously, the 50-mile segment of the State line crossing the Bruneau River drainage system is somewhat more favorable for ground-water underflow. The headwater area receives much precipitation; the main stream gradients crossing the State line are more than 30 feet per mile northward; land-surface gradients generally are more than 200 feet per mile northward; and the volcanic and associated sedimentary rocks dip generally northward. These favorable features are offset to a considerable degree by the fact that the streams are incised several hundred feet below the general land surface. The streams thus are able to function as ground-water drains. This results in diverting part of the northward moving ground water to the streams and thus reducing the amount of underflow crossing the State line. Many more data are required to determine the amount of this underflow, but based on apparent conditions, the annual amount of underflow moving northward across the State line probably is not larger than several tens of thousands of acre-feet per year.

SURFACE WATER

Monthly and annual records of streamflow for the Snake River basin in Nevada are compiled in U.S. Geological Survey Water-Supply Papers 1317 and 1737. The former covers records prior to and including 1950, the latter covers the period 1951 to 1960. Prior to 1961 records were published annually in Water-Supply Papers; since 1961 streamflow data have been published in annual reports entitled "Surface Water Records in Nevada." In this report, miscellaneous discharge measurements made by the Geological Survey and the Nevada Fish and Game Commission have been tabulated and grouped by principal streams.

Streamflow is measured on most of the principal and some of the smaller streams in the Snake River basin in Nevada. There remains, however, numerous small streams that locally and collectively are important to the hydrology and economy of the area. Methods have been devised recently to estimate runoff in Nevada, particularly for application to areas where little or no streamflow records are available. These methods are described in detail by Moore (1968).

Using the drainage areas supplying the natural flow to streams where gaging stations had been or are operated, recorded runoff is prorated by altitude zones (1,000-foot intervals) with due regard to the proportional areas of the several zones and with increasing unit values of runoff for increasing altitude. Vegetation, geology, soil, and precipitation, vary locally within large areas and affect runoff. The runoff coefficient for each altitude increment is adjusted for the combined effect of these parameters. The adjustment of the runoff coefficients for local conditions is based on measurements of streamflow and channel geometry.

As used in this report, <u>streamflow</u> refers to the flow that occurs in a natural channel. Streamflow may be applied to flow whether or not it is affected by diversion or vegetation. Inflow or outflow refers to streamflow across the State line. <u>Runoff</u> refers to natural flow from an area. For areas where stream gradients are steep, natural evapotranspiration from overland runoff are small, or where diversions are negligible runoff and streamflow values may be about equal, such as in Jarbidge River Valley. Ordinarily, however, evapotranspiration or infiltration losses along the stream system reduce the streamflow considerably. For example, in the Nevada segment of Salmon Falls Creek Valley, streamflow from Nevada is about 63 percent of the estimated runoff generated in Nevada.

The following sections discuss streamflow data, characteristics, runoff, and outflow from Nevada by the principal stream system in the basin.

Goose Creek Valley

Drainage

Goose Creek Valley is a northeast-trending valley on the eastern end of the Snake River basin in Nevada. The valley consists mainly of rolling hills with the steeper slopes next to the streams. Goose Creek is the largest stream and originates in Idaho and flows southward for about 10 miles after entering Nevada and then turns northeastward into Idaho after crossing the northwest corner of Utah. The largest tributaries are Fine, Trout, and Jay Creeks which drain part of the highland in Idaho, and Little Goose Creek, which drains the west part of the valley. These tributaries are perennial but tributaries draining the south part of the valley are ephemeral.

Records Available

Goose Creek is gaged about 13 miles downstream from the Nevada State line in sec. 13, T. 15 S., R. 21 E., about 5 miles upstream from Trapper Creek. Records are available at this gage (Goose Creek above Trapper Creek near Oakley, Idaho) for the period April 1911 to September 1916 and March 1919 to the present time. No gaging stations have been operated in the Nevada part of Goose Creek Valley.

During the present investigation miscellaneous measurements of streamflow were made on several tributaries of Goose Creek and on the main stem. Miscellaneous streamflow measurements also were available that were made by the State of Nevada Fish and Game Commission.

Table 5 summarizes monthly and annual streamflow of Goose Creek at the station near Oakley, Idaho. The data for the miscellaneous measurements are shown in table 6. The gaging station and miscellaneous measurement sites are shown on plate 1.

Characteristics of Streamflow

Runoff in Goose Creek Valley is mainly influenced by snowmelt as are the other valleys in the Snake River basin in Nevada. The data in table 5 and the graphs in figure 7 show the annual streamflow pattern for Goose Creek above Trapper Creek near Oakley, Idaho for the water years 1920-65. The monthly plot points are shown as a percentage of the average annual streamflow. The middle line of the graph represents the median distribution of the monthly mean discharge for each month; that is, for each month, 50 percent of the monthly flows of record were less than and 50 percent were more than the proportional

Table 5.--Summary of streamflow, in cfs, at gaging station on Goose Creek

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year
Goose Creek above Trapper Creek near Oakley, Idaho, for water years 1920-65													
Average	16.4	22.5	22.3	25.9	45.7	61.1	96.9	135	59.1	15.7	10.2	9.11	43.3
Max. month	39.7	38.8	45.3	79.4	241	289	224	551	258	73.5	39.8	27.3	[a]145
Min. month	6.88	12.6	14.0	11.4	15.9	31.2	25.9	13.4	7.70	0.63	0	0	[b]15.3

a Maximum recorded water year (1921).

b Minimum recorded water year (1934).

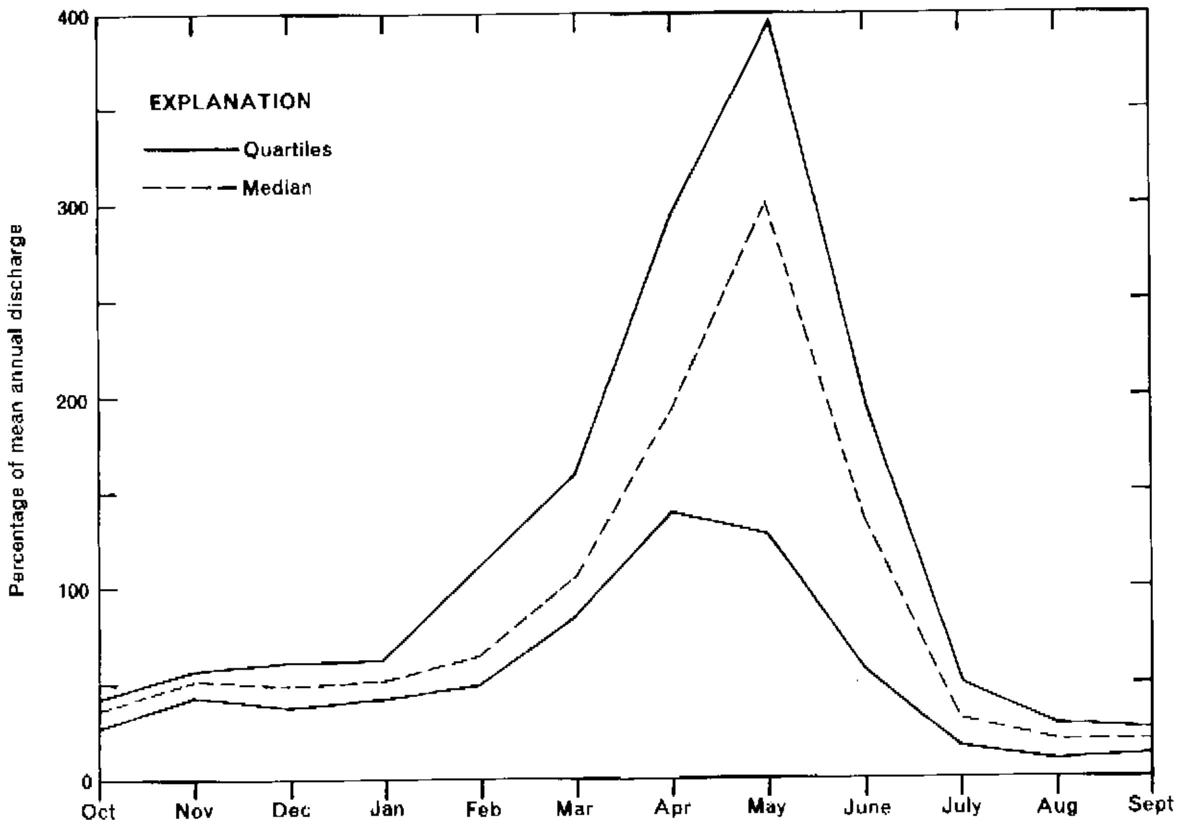


Figure 7.—Graphs of monthly discharge as a percentage of mean annual discharge of Goose Creek above Trapper Creek, near Oakley, Idaho (1920-65).

Table 6.--Miscellaneous streamflow measurements made in Goose Creek Valley

Stream name	Location 1/	Map no.	Date	Discharge (cfs)
Pine Creek	47/68-11	123	8- 5-52	1.67*
Coon Creek	47/68-21	124	8- 4-52	1.8*
Goose Creek	47/68-22	125	7-11-66	4.98
Little Goose Creek	46/67-12	126	8- 7-52	.002*
Do.	46/68-30	127	7-15-52 7-11-66	1.0* .67
Trout Creek	47/69-8	128	7-11-66	2.77
Do.	47/69-33	129	7-21-52	4.0*
Goose Creek	47/69-36	130	8- 5-52	12.4*
Do.	47/70-19	131	7-11-66	4.23

1. Locations are given in order by township, range, and section. Thus, location 47/68-11 is T. 47 N., R. 68 E., sec. 11 of the Mount Diablo base line and meridian.

* Furnished by State of Nevada Fish and Game Commission.

amount shown on the graph. The upper line of the graph, the upper quartile, is a plot of the proportional monthly flow for which only 25 percent of the monthly flows of record were higher than and 75 percent were less than the proportions indicated.

The lower line of the graph, the lower quartile, is a plot of the monthly proportion of annual flow for which 75 percent of the monthly flows of record were greater than and 25 percent were less than the proportion indicated by the line. The principal streamflow occurs in the March to June period from snowmelt. During this time about 68 percent of the annual discharge occurs. In the 46-year period of record, the maximum monthly discharge occurred 32 times in May, 12 times in April, and 2 times in March. The instantaneous peak flow was 3,240 cfs on February 11, 1962.

The August to October runoff is low with monthly averages of between 9 and 17 cfs. Periods of no flow occurred in 1934, 1935, 1940, and 1947.

Estimated Runoff

The average annual runoff, based on runoff-altitude relations in Goose Creek Valley, is estimated to be 52,000 acre-feet. Table 7 summarizes the runoff for different areas. Most of the runoff is supplied from the northern part of the drainage area.

Inflow and Outflow

The inflow from Idaho occurs in Upper Goose, Trout, and Jay Creeks and was computed from channel geometry to be about 7,000 acre-feet. The outflow in Goose Creek similarly was computed to be 30,000 acre-feet. Thus, the estimated net outflow from Nevada is 23,000 acre-feet per year.

Salmon Falls Creek Valley

Drainage

Salmon Falls Creek Valley is a horseshoe-shaped valley in the eastern half of the Snake River basin in Nevada. The relatively flat floor of the valley is enclosed by steepsided mountains. Salmon Falls Creek, originates in the northwest corner of the valley, flows southerly to a point south of Contact, turns northward and flows across the State line into Idaho. Runoff is principally generated in the headwaters of Salmon Falls Creek. South Fork Salmon Falls Creek and its principal tributaries drain the east flank of the Jarbidge Mountains. North Fork Salmon Falls Creek and its western tributaries drain the east flank of the Elk

Table 7.--Estimated average annual runoff in Goose Creek Valley

(Runoff values rounded to two figures)

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Area north of Litt e Goose Creek and Goose Creek	72,230	35	27,000	52
Area south of Little Goose Creek and Goose Creek	132,300	65	25,000	48
Total (rounded)	204,500	100	52,000	100

Mountains. Shoshone Creek drains the northeast part of Salmon Falls Creek Valley, including that part in Idaho. It flows into Salmon Falls Creek just before it crosses the Nevada State line. Other streams include Willow, Trout, and Cottonwood Creeks. Most of the streams are perennial except those in the southern and southeast sides which are ephemeral or intermittent.

Records Available

Salmon Falls Creek is currently gaged in the NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 23, T. 47 N., R. 64 E., about 550 feet below Shoshone Creek. Records of streamflow for this gage (Salmon Falls Creek near San Jacinto) are available for the period June 1910 to September 1916 and from October 1918 to the present time.

Streamflow records have been obtained on the main stem of Salmon Falls Creek above upper Vineyard ditch in NW$\frac{1}{4}$ sec. 5, T. 44 N., R. 63 E. Streamflow records for this gage (Salmon Falls Creek above upper Vineyard ditch, near Contact) are available for May 1914 to July 1915 and October 1948 to September 1962.

Many streamflow gages have been operated for short periods on the main stem of Salmon Falls Creek and its tributaries. The following lists several of the gages, locations, and the periods for which streamflow data is available.

Jakes Creek above Hubbard Ranch, near Contact	Sec. 9, T. 43 N., R. 63 E.	May to September 1914
Willow Creek near Contact	Sec. 23, T. 43 N., R. 63 E.	May to September 1914
Jakes Creek below Hubbard Ranch, near Contact	Sec. 33, T. 44 N., R. 63 E.	May to September 1914
Salmon Falls Creek below High Line Canal, near San Jacinto	Sec. 27, T. 46 N., R. 64 E.	July to September 1914
Trout Creek near San Jacinto	Sec. 5, T. 46 N., R. 65 E.	May to September 1914
Shoshone Creek near San Jacinto	Sec. 17, T. 47 N., R. 65 E.	June to November 1914, March to July 1915

Also, several of the ditches used for irrigation have seasonal streamflow records in 1914. A number of sites were gaged during the irrigation seasons of 1949 and 1950, although the records are unpublished.

During the present investigation, miscellaneous measurements of streamflow were made on most of the tributaries to Salmon Falls Creek and also on the main stem. Miscellaneous measurements of streamflow were made previously by the State of Nevada Fish and Game Commission.

Table 8 summarizes the monthly and annual streamflow of Salmon Falls Creek at two gaging sites. The data for the miscellaneous measurements are shown in table 9. Gaging stations and miscellaneous measurement sites are shown on plate 1.

Characteristics of Streamflow

Snowmelt has the dominant influence on runoff in Salmon Falls Creek Valley. Table 8 indicates and figure 8 illustrates that the major discharge occurs in the period March to June. In 14 water years (1949-62) the record for Salmon Falls Creek above upper Vineyard ditch near Contact, indicates that about 87 percent of the streamflow occurred in the 3-month period April to June. In 47 water years (1919-65) the record for Salmon Falls Creek near San Jacinto indicates that about 74 percent of the streamflow occurred in a 4-month period March to June. During 47 years of record the maximum monthly discharge occurred 31 times in May, 15 times in April, and once in March.

May has the highest monthly average discharge at both stations. The instantaneous peak flow for the period of record at the gage near Contact was 4,420 cfs on February 12, 1962. Similarly, the instantaneous peak flow at the gage near San Jacinto was 1,970 cfs on February 12, 1962.

Normally the low flow period extends from August to January at both gages but the lowest monthly flows are generally in August. The minimum flow for the period of record at the upper gage was 6.8 cfs on December 26, 1954, and the minimum flow at the lower gage was 2.6 cfs on September 4, 1961.

Estimated Runoff

The average annual runoff, based on runoff-altitude relations in the Salmon Falls Creek Valley, is estimated to be 140,000 acre-feet. Table 10 summarizes the runoff for different areas.

Table 8.--Summary of streamflow, in cfs, at gaging stations in Salmon Falls Creek Valley

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year
Salmon Falls Creek above upper Vineyard ditch, near Contact, Nevada, for water years 1949-62													
Average	25.0	28.9	30.4	30.7	53.7	67.8	213	340	201	44.8	21.9	20.2	91.4
Max. month	29.3	33.2	40.4	47.1	245	147	435	705	369	80.1	29.9	23.5	[a]172
Min. month	20.4	23.9	21.8	21.5	23.6	29.3	45.3	85.7	58.5	18.7	17.0	16.7	[b]38.0
Salmon Falls Creek near San Jacinto, Nevada, for water years 1919-65													
Average	61.1	55.7	54.7	61.8	96.4	140	337	436	255	55.3	23.9	27.5	132
Max. month	455	80.1	130	152	377	455	865	1,000	706	116	67.1	55.9	[a]288
Min. month	25.8	41.3	36.9	38.0	44.4	55.5	77.4	52.0	24.1	12.5	8.16	9.79	[b]45.4

a Maximum recorded water year.

b Minimum recorded water year.

Table 9.--Miscellaneous streamflow measurements made in Salmon Falls Creek Valley

Stream name	Location[1]	Map no.	Date	Discharge (cfs)
N.F. Salmon Falls Creek	47/62-35	100	7-10-66	1.70
Lime Creek	47/62-31	101	10-10-52	1.81*
Wilson Creek	46/62-9	102	8-24-52	2.8*
			7-10-66	1.86
Canyon Creek	45/61-17	103	7-10-66	5.53
Do.	45/61-15	104	8-28-52	3.3
Middle Fork Cottonwood Creek	45/60-35	105	7-10-66	0
N.F. Cottonwood Creek	45/60-36	106	7-10-66	.07
Camp Creek	44/60-10	107	8-20-52	2.25*
Do.	44/60-12	108	7-10-66	.08
Sun Creek	44/60-36	109	7-11-66	1.60
Do.	44/60-20	110	8-21-55	.24*
Do.	44/61-21	111	8-21-55	1.65*
Dry Creek	42/62-14	112	8-25-52	.70*
Jakes Creek	43/62-28	113	8-29-52	2.5*
Do.	43/63-9	114	8-25-52	.15*
Salmon Falls Creek	45/64-30	115	4-13-47	94.9
			5-20-47	155
			7-23-47	27.2
			9- 1-47	20.0
			10-15-47	29.8
			12-15-47	36.8
			1-22-48	35.4
			3- 1-48	43.4
			4-17-48	101
			5-15-48	212
			6- 3-48	370
			6-16-48	212
			7-15-48	60.1
			8-12-48	19.7
			8-29-54	20*
Trout Creek	44/65-3	116	8-14-52	.32*
Do.	46/65-24	117	7-10-66	0
Hot Creek	47/67-6	118	7-11-66	.80
Indian Mike Creek	47/66-12	119	7-11-66	.02 E
Shoshone Creek	(a)	120	7-11-66	5.84
Do.	47/65-12	121	8- 8-52	7.3*
Cottonwood Creek	47/63-24	122	7-10-66	.17

1. Locations are given in order by township, range, and section. Thus, location 47/62-35 is T. 47 N., R. 62 E., sec. 35 of the Mount Diablo base line and meridian.
* Furnished by State of Nevada Fish and Game Commission.
E. Estimated.
a. T. 16 S., R. 16 E., sec. 24, Boise base line and meridian.

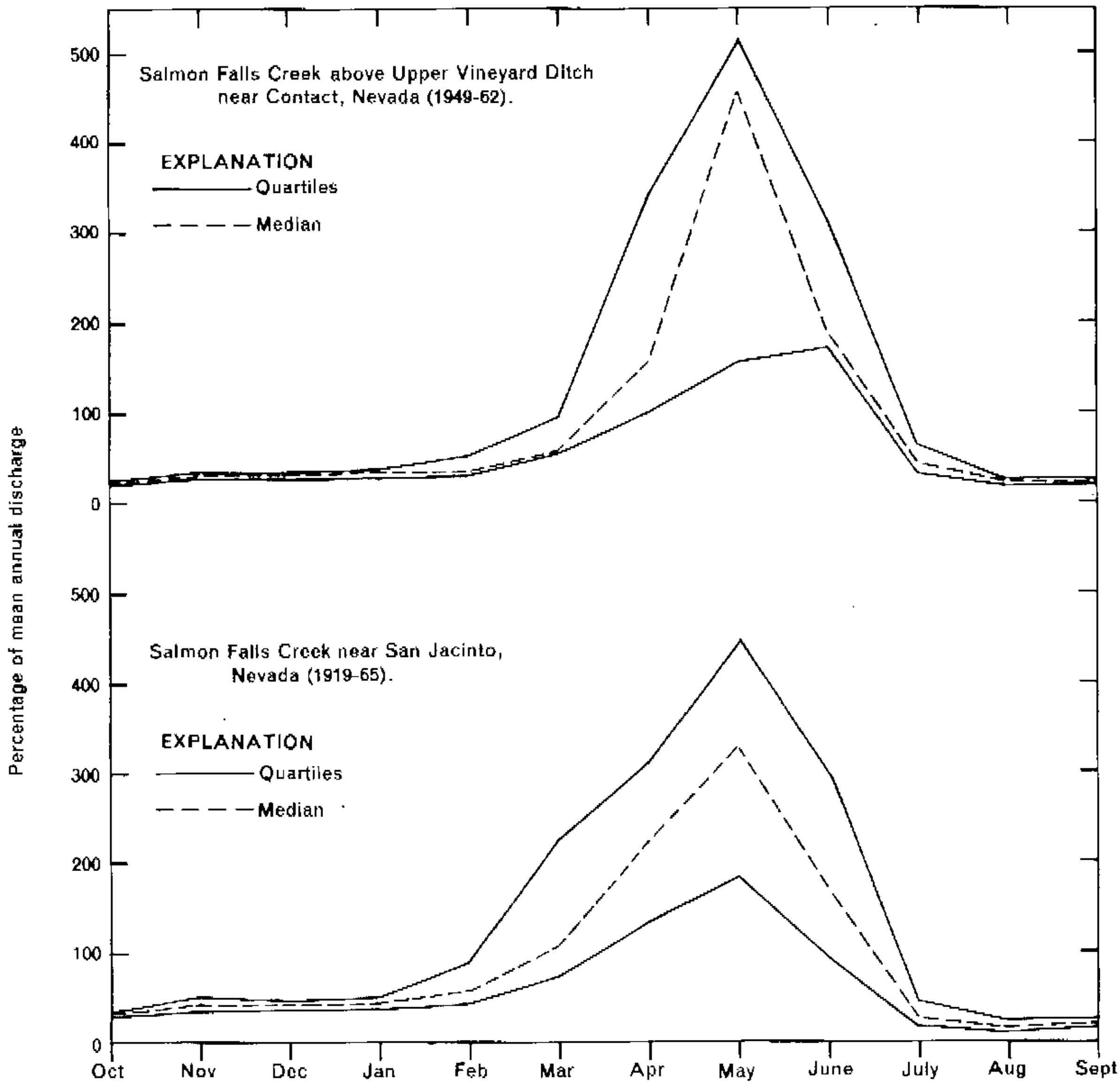


Figure 8.—Graphs of monthly discharge as a percentage of mean annual discharge of Salmon Falls Creek.

Table 10.--Estimated average annual runoff in Salmon Falls Creek Valley

(Runoff values rounded to two figures)

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Upstream from Bad Lands	249,600	32	95,000	66
West side of Bull Camp Creek upstream from Henry, Nevada	122,000	16	10,000	7
West side of Salmon Falls Creek, downstream from Henry, Nevada	116,700	15	4,000	3
East side of Bull Camp Creek and Salmon Falls Creek to Trout Creek	145,100	19	20,000	14
East side of Salmon Falls Creek north of Trout Creek	137,500	18	15,000	10
Total	770,900	100	140,000	100

Inflow and Outflow

The major inflow into Nevada occurs in two streams, the headwaters of North Fork Salmon Falls Creek and most of the drainage area of Shoshone Creek. The inflow to Nevada from North Fork Salmon Falls Creek, based on channel geometry, was computed as 3,000 acre-feet and the inflow from Shoshone Creek as 7,000 acre-feet, or a total inflow of about 10,000 acre-feet. The outflow occurs in the stream channel of Salmon Falls Creek, and was computed to be 98,000 acre-feet. This value is slightly higher than the average discharge for the gage near San Jacinto. The increase is due to the additional drainage area, mainly Cottonwood Creek which enters the stream between the gage and the State line. The net outflow from Nevada is about 88,000 acre-feet per year.

Bruneau River Valley

Drainage

The Bruneau River Valley is a northwest-trending valley in the central part of the Snake River basin in Nevada. The drainage area of the valley generally is mountainous with steep slopes. The southern part of the upland area has somewhat more rounded form and lesser slopes. In the vicinity of Charleston and southward, the valley floor has been widened locally during Quaternary time to form a relatively flat flood plain. The Bruneau River is the largest stream in the valley. It originates in the southern end of the valley and flows out the northern end to Idaho. Meadow Creek is the largest tributary flowing into Bruneau River in Nevada. However, several other streams draining both sides of the valley are tributary to the Bruneau River. Most of the streams draining to the Bruneau River in Nevada are perennial.

Records Available

A gaging station (Bruneau River near Rowland) in SE$\frac{1}{4}$ sec. 29, T. 47 N., R. 56 E., about one-half mile below Taylor Creek was operated from June 1913 to September 1918.

Another gaging station (Bruneau River near Tindall, Idaho) about 10 miles downstream from the Nevada State line in sec. 7, T. 15 S., R. 7 E., was operated from September 1910 to April 1912. A gaging station was operated from January 1911 to August 1913 on Sheep Creek which originates in Nevada. This gage (Sheep Creek near Tindall, Idaho) was about 11 miles north of the State line in sec. 5, T. 15 S., R. 6 E. Since these early periods of record, no gaging stations were operated on the Bruneau River in Nevada until recently. In September 1966 a gaging station was re-established at Rowland.

Miscellaneous measurements have been made on the Bruneau River and several of its tributaries during the present investigation and as a part of an investigation of stream systems by H. C. Riggs of the Geological Survey. Miscellaneous streamflow measurements also have been made by the State of Nevada Fish and Game Commission.

Monthly and annual streamflow, as recorded at the site near Rowland, 1914-18, are summarized in table 11. The data for the miscellaneous measurements are shown in table 12. Gaging stations and miscellaneous measurement sites are shown on plate 1.

Characteristics of Streamflow

Streamflow in the Bruneau River Valley is derived mainly from snowmelt. The data in table 11 and illustrated in figure 9 shows that the principal discharge of the Bruneau River occurs during the period March to June. In five water years (1914-18) more than 78 percent of the annual streamflow occurred during this 4-month period, with the maximum monthly discharge in May. The instantaneous peak flow was 1,440 cfs on May 14, 1917 and minimum daily flow was 5 cfs on August 11-14 and August 26 to September 1, 1918.

Estimated Runoff

The average annual runoff of the Bruneau River is estimated to be 110,000 acre-feet, based on the runoff-altitude relations. Table 13 summarizes the runoff for different areas. The runoff is fairly well distributed throughout the valley.

Inflow and Outflow

There is no inflow into Nevada from Idaho in the Bruneau River Valley. The greatest part of the outflow from Nevada occurs in the main channel of the Bruneau River but some outflow occurs in Sheep, Cottonwood, and Cat Creeks. The total outflow, based on geometry of the channels near the State line, was computed to be about 96,000 acre-feet per year with 90 percent occurring in the Bruneau River and about 10 percent in Sheep, Cottonwood, and Cat Creeks.

Jarbidge River Valley

Drainage

The Jarbidge River Valley is a north-trending valley in the central part of the Snake River basin in Nevada. It includes the drainage area from Elk Mountain west to the eastern drainage divide of the main stem Bruneau River near the State line. The

Table 11.--Summary of streamflow, in cfs, at gaging station in Bruneau River Valley

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year
Bruneau River near Rowland, Nevada, for water years 1914-18													
Average	24.3	28.4	25.5	27.6	41.9	154	431	390	245	54.3	13.6	13.8	121
Max. month	29.9	40.7	33.2	41.7	50.4	254	666	764	511	126	21.1	17.1	[a]174
Min. month	19.3	24.2	14.7	20.0	28.8	66.2	186	183	115	12.6	6.1	9.1	[b]63.3

a Maximum recorded water year.

b Minimum recorded water year.

Table 12.--Miscellaneous streamflow measurements made in Bruneau River Valley

Stream name	Location[1/]	Map no.	Date	Discharge (cfs)
Bruneau River	42/58-20	60	2-11-62	1,890
			--	12
			9- 5-62	2.0
			9- 8-62	1.7
			3-19-63	.45
			5-30-63	1.9
			6-11-63	6.0
			7-11-63	.48
			8-30-63	.5
			4-16-64	4.9
			4-23-64	3.79
			5-24-64	.96
			6-16-64	1.93
			7- 8-64	.68
			8-12-64	.70
Bruneau River	42/58-18	61	11-16-61	1.70
			4-11-62	7.46
			4-25-62	4.24
			5-30-62	4.44
			6-19-62	1.35
			7-11-62	.59
			8- 8-62	.61
Mason Creek	43/57-36	62	9-13-47	0
Bruneau River	43/57-26	63	8-14-63	.2
Seventy-Six Creek	44/57-13	64	9- 5-62	.1
			9- 8-62	.1
			3-19-63	.5
			5-24-63	16
			5-30-63	1.57
			6-11-63	5.54
			7-11-63	.58
			8-14-63	.05
			8-31-63	.05
			4-16-64	11
			4-23-64	6.28
			5-24-64	2.85
			6-16-64	5.18
			7- 9-64	1.11
			8-12-64	.15
Seventy-Six Creek	44/57-23	65	8-14-63	.5
Badger Creek	44/57-27	66	8-14-63	0
			10- 8-64	.1
			9- 7-65	.1

Table 12.--Continued

Stream name	Location[1/]	Map no.	Date	Discharge (cfs)
Cooper Creek	45/57-25	67	9-14-47	1.4
			7-31-57	4.00*
Do.	44/57-16	68	9-13-47	.4
			7-30-57	2.16*
			8-14-63	2.39
			10- 8-64	.38
			9- 7-65	3.79
			4- 6-66	20.9
Deer Creek	45/57-5	69	8-14-63	.2
Fawn Creek	45/57-29	70	8-14-63	0
Cottonwood Creek	45/57-18	71	8-14-63	.3
Little Cottonwood	do.	72	8-14-63	.1
Coon Creek	46/57-31	73	9-13-47	1.4
			8-14-63	3.60
			4-16-66	11.0
Bruneau River	46/56-5	74	11-16-61	9.81
			2-11-62	2,120
			4-11-62	350
			4-24-62	559
			5-29-62	473
			6-20-62	294
			7-12-62	61.5
			8- 9-62	21.0
			8-17-62	14.6
			9- 7-62	3.0
			5-30-63	254
			6- 4-63	1,270
			7-11-63	93.6
			8-15-63	21.9
			8-30-63	15.2
			4-17-64	600
			4-22-64	314
			5-22-64	312
			6-18-64	291
			7- 8-64	81.2
			8-12-64	17.2
Meadow Creek	45/56-7	75	7-15-53	1.81*
Do.	46/55-25	76	9-12-47	.8
Telephone Creek	46/55-34	77	7- 6-53	1.53*
Tennessee Creek	46/56-17	78	7- 9-53	1.07*
Meadow Creek	46/56-5	79	6-29-53	3.93*
			9- 7-62	1.00
			5-30-63	25.6
			6- 4-63	940
			6-15-63	78.9
			7-11-63	14.4
			8-15-63	1.0

Table 12.--Continued

Stream name	Location[1/]	Map no.	Date	Discharge (cfs)
Meadow Creek	46/56-5	79	8-30-63	0.75
			4-16-64	185.
			4-22-64	69.9
			5-24-64	56.7
			6-18-64	28.4
			7- 8-64	8.82
			8-12-64	.40
			10- 7-64	1.25
			9- 7-65	2.70
			3-16-66	10.5
			4-14-66	27.2
			5-17-66	14.6
McDonald Creek	47/55-33	80	11- 4-62	.2
			5-31-63	14.0
			6-15-63	29.4
			7-12-63	2.99
			8-29-63	1.28
			4-16-64	26
			5-24-64	22.3
			6-17-64	16.0
			7- 7-64	6.97
			8-11-64	1.75
Do.	47/55-22	81	7- 7-53	3.01*
Do.	47/56-17	82	9-16-47	.4
Bruneau River	47/54-16	83	7-12-66	5.68
Merritt Creek	46/54-4	84	8-15-63	.5
Sagehen Creek	46/54-3	85	8-15-63	.1
Merritt Creek	47/54-34	86	8-17-53	.79*
Sheep Creek	47/54-8	87	8-17-53	2.40*
			7-12-66	.77
Little Salmon Creek	47/54-14	88	8-15-63	.1
Salmon Creek	do.	89	8-15-63	.1

Table 12.--Continued

Stream name	Location[1/]	Map no.	Date	Discharge (cfs)
Cat Creek	(a)	90	9- 4-62	0
			10-11-62	0
			3-20-63	.2
			5-31-63	1.5
			6- 2-63	34
			6-15-63	9.37
			7-12-63	.02
			8-29-63	0
			10- 3-63	0
			4-17-64	22
			4-21-64	4.72
			5-24-64	4.00
			7- 7-64	.60
			8-11-64	0

1. Locations are given in order by township, range, and section. Thus, 42/58-20 is T. 42 N., R. 58 E., sec. 20 of the Mount Diablo base line and meridian.

* Furnished by State of Nevada Fish and Game Commission.

a. T. 16 S., R. 6 E., sec. 15, Boise base line and meridian.

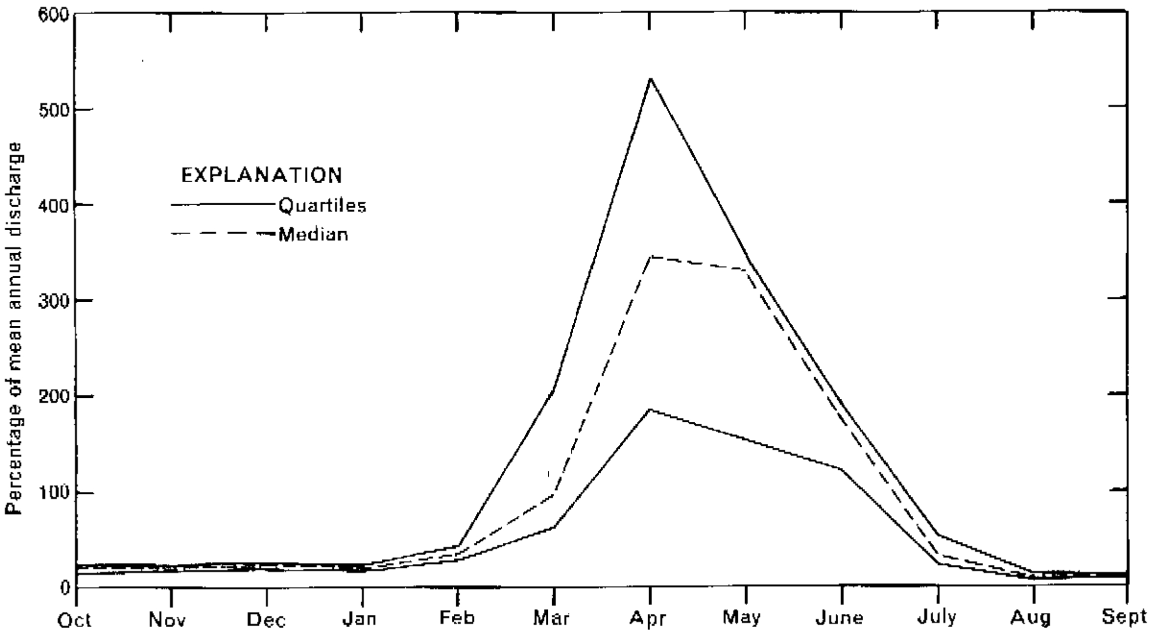


Figure 9.—Graph of monthly discharge as a percentage of mean annual discharge of the Bruneau River near Rowland, Nevada (1914-18).

Table 13.--Estimated average annual runoff in Bruneau River Valley

(Runoff values rounded to two figures)

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Area west of Bruneau River and south of lat 41°46' N.	70,070	22	17,000	16
Area west of Bruneau River and north of lat 41°46' N.	122,600	37	42,000	40
Area east of Bruneau River and south of lat 41°46' N.	77,920	24	34,000	32
Area west of Bruneau River and north of lat 41°46' N.	54,980	17	13,000	12
Total (rounded)	325,600	100	110,000	100

southern end of the valley is mountainous with steep slopes, whereas the northern part of the valley is a relatively flat, north-dipping tableland with the streams in nearly vertically-sided canyons. The Jarbidge River and the East Fork Jarbidge River are the main streams in the valley. These streams originate in the higher parts of the Jarbidge Mountains and flow north into Idaho, where they join the Bruneau River. Several other small streams originate in Nevada and flow north into Idaho, such as Dorsea, Columbet, Buck, Rattlesnake, Poison, Spring, Pole Flat, Cherry, Anna, Three, Deer, and Deadwood Creeks. Most of the streams in the area are perennial except those east of and including Poison Creek, which go dry during extremely dry years.

Records Available

No gaged streamflow record has been obtained in Nevada in the Jarbidge River Valley.

The East Fork Jarbidge River is gaged about 3 miles downstream from the Nevada State line. This gage (East Fork Jarbidge River near Three Creek, Idaho) is about 2 miles above its mouth in SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 14, T. 16 S., R. 9 E. Records are available for this gage from October 1928 to March 1933 and September 1953 to the present time.

Within a few miles downstream from the Nevada State line short-period records of streamflow are available for Three, Cherry, and Deadwood Creeks and East Fork Bruneau River which originate in Nevada. The gage name, location, and period of record are shown in the following tabulation for these stations.

Gage name	Location	Period of record
Three Creek near Three Creek, Idaho	Sec. 27, T. 15 S., R. 11 E.	December 1912 to June 1914, March to June 1916
Cherry Creek near Three Creek, Idaho	SE$\frac{1}{4}$ sec. 32, T. 15 S., R. 11 E.	December 1912 to June 1914, March to June 1916
Deadwood Creek near Three Creek, Idaho	Sec. 19, T. 15 S., R. 12 E.	December 1912 to June 1914, April to June 1916
East Fork Bruneau River near Three Creek, Idaho	Sec. 7, T. 16 S., R. 11 E.	December 1912 to June 1914, March to June 1916

Miscellaneous measurements of streamflow have been made on most of the streams in the valley during the present investigation and as a part of an investigation of stream systems by H. C. Riggs of the Geological Survey. Miscellaneous streamflow measurements also were made by the State of Nevada Fish and Game Commission.

Table 14 summarizes the monthly and annual flow of the East Fork Jarbidge River, near Three Creek. The data for the miscellaneous measurements are shown in table 15. Gaging stations and miscellaneous measurement sites are shown on plate 1.

Characteristics of Streamflow

The Jarbidge River Valley in Nevada reflects a more dominant influence of snowmelt runoff than the other valleys in the Snake River basin. The data in table 14 indicate and figure 10 illustrates the annual streamflow pattern for East Fork Jarbidge River near Three Fork, Idaho for the water years 1954-65. The major discharge occurs as snowmelt during the April to July period. During the 12 years of record, 78 percent or more of the annual discharge occurred during the April to July period. More than 60 percent of the annual discharge occurred during the two months of May and June, except in 1954 and 1965 when 58 percent and 54 percent occurred, respectively. The maximum instantaneous peak flow was 693 cfs on June 24, 1962. The low flow period generally occurs from September to January. The minimum instantaneous flow was 0.7 cfs on December 23 and 25, 1962.

Estimated Runoff

The average annual runoff in the Jarbidge River Valley, based on runoff-altitude relations, is estimated to be 98,000 acre-feet. The runoff is well distributed throughout the valley. Table 16 summarizes the runoff for different areas.

Inflow and Outflow

There is no inflow into Nevada in the Jarbidge River Valley. The major outflow from Nevada occurs in the Jarbidge and East Fork Jarbidge Rivers. The total outflow, based on channel geometry, was computed to be 93,000 acre-feet. The Jarbidge and East Fork Jarbidge Rivers (including outflow from Buck Creek) discharge about 73,000 acre-feet. The remainder of about 20,000 acre-feet flowing out of the State of Nevada is streamflow largely in Columbet, Rattlesnake, Spring, Pole, Three, and Deer Creeks.

Table 14.--Summary of streamflow, in cfs, at gaging station in Jarbidge River Valley

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year
	East Fork Jarbidge River near Three Creek, Idaho, for water years 1954-65												
Average	11.7	11.2	13.4	11.7	16.5	22.3	69.3	194	258	80.0	20.0	12.1	60.0
Max. month	29.2	16.9	35.8	28.2	34.5	46.6	118	284	408	188	50.0	22.8	[a]92.0
Min. month	6.05	6.45	6.53	6.86	6.30	8.17	24.8	106	89.2	16.4	7.76	5.05	[b]30.9

a Maximum recorded water year.

b Minimum recorded water year.

Table 15.--Miscellaneous streamflow measurements

in Jarbidge River Valley

Stream name	Location[1]	Map no.	Date	Discharge (cfs)
Dave Creek	47/58-24	91	8-26-57	2.44*
Do.	47/58-12	92	8-27-57	2.12*
			5-20-66	5.11
Jarbidge River	46/58-21	93	4-24-64	30.4
			5-22-64	206
			5-27-64	272
			6-18-64	160
			6-19-64	142
			7- 9-64	43.9
			8-12-64	6.20
Do.	46/58-4	94	8-14-63	15.7
Jack Creek	46/58-28	95	9- 6-65	1.84
Do.	46/58-4	96	8-14-63	3.54
			10- 6-64	.8
			9- 7-65	2.51
			3-18-66	.92
Buck Creek	47/58-9	97	5-29-63	15.0
			6- 6-63	276
			7-10-63	12.8
			8-31-63	3.37
			4-24-64	11.2
			5-22-64	32.1
			6- 7-64	43
			6-18-64	22.4
			7- 8-64	13.0
			8-12-64	2.99
Columbet Creek	47/57-13	98	9- 4-62	.25
			3-19-63	0
			5-29-63	2.48
			6- 6-63	32
			6-17-63	8.57
			7-10-63	1.36
			8-31-63	.3
			4-24-64	2.20
			5-22-64	5.77
			6-18-64	4.76
			7- 8-64	1.47
			8-12-64	.20
Pole Creek	46/59-12	99	8-13-63	.1

1. Locations are given in order by township, range, and section. Thus, location 47/58-24 is T. 47 N., R. 58 E., sec. 24 of the Mount Diablo base line and meridian.

* Furnished by State of Nevada Fish and Game Commission.

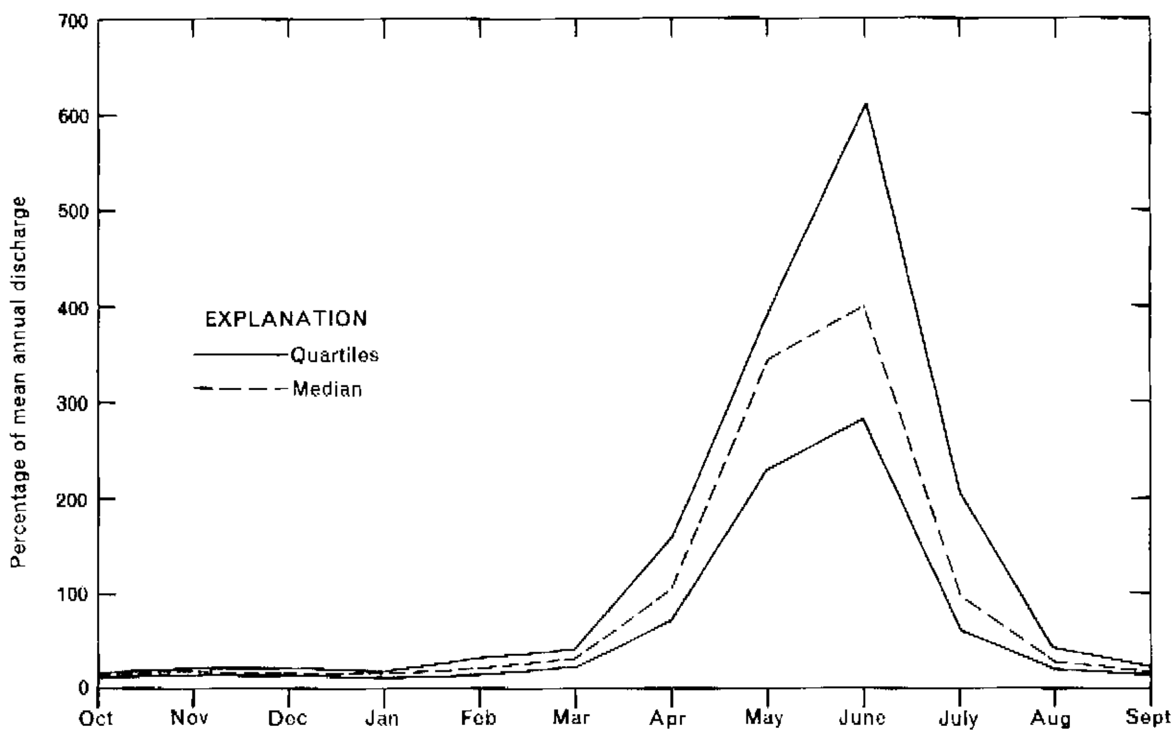


Figure 10.—Graphs of monthly discharge as a percentage of mean annual discharge of the East Fork of the Jarbidge River near Three Creek, Idaho (1954-65).

Table 16.--Estimated average annual runoff in Jarbidge River Valley

(Runoff values rounded to two figures)

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Area west of Rattlesnake Creek	68,700	40	37,000	38
Area between Rattlesnake Creek and East Fork Jarbidge River	28,340	16	20,000	20
Area east of East Fork Jarbidge River	77,250	44	41,000	42
Total (rounded)	174,300	100	98,000	100

Owyhee River Valley

Drainage

The Owyhee River Valley is a northwest-trending valley near the central part of the Snake River basin in Nevada. The valley is moderately mountainous, except Duck Valley in the northwest part which has low relief. The Owyhee River originates in the highlands in the southern part of the valley. The flow of the Owyhee River has been regulated by Wild Horse Reservoir since March 1938. Several tributaries flow into the Owyhee River, the largest are those between Wild Horse Reservoir and Mountain City. Many of the streams are perennial.

Records Available

The Owyhee River is currently gaged at two sites on the main stem. The gage at the upper site, Owyhee River near Gold Creek, is in $NW\frac{1}{4}NW\frac{1}{4}$ sec. 25, T. 44 N., R. 54 E., about 500 feet downstream from Wild Horse Reservoir. (See pl. 1.) Streamflow records have been collected for the periods March to November 1916, April 1917 to September 1925, and October 1936 to the present.

The lower gage, Owyhee River above China diversion dam, near Owyhee, is in $NW\frac{1}{4}$ sec. 6, T. 46 N., R. 53 E., about 1,000 feet downstream from Skull Creek. The gage was installed in March 1939 and streamflow records have been continuous to the present time. The Owyhee River was gaged at two other sites in the past. One of these gages, Owyhee River near Mountain City, was in $SW\frac{1}{4}$ sec. 35, T. 46 N., R. 53 E., about 1 mile downstream from California Creek. Streamflow was recorded at this site from June 1913 to December 1914, and December 1926 to December 1948.

The other gage, Owyhee River near Owyhee, was in $E\frac{1}{2}$ sec. 21, T. 46 N., R. 53 E., about 40 feet above Jones Brook. Streamflow was recorded at this site from October 1913 to September 1914, April 1915 to October 1916, May 1917 to September 1919, November, December 1919, May 1920, August 1921, and October 1921 to June 1926.

Records of contents have been obtained on Wild Horse Reservoir at the dam from March 1938 to the present time. During the present investigation miscellaneous measurements of streamflow were made on most of the tributaries to the Owyhee River and also on the main stem. Miscellaneous streamflow measurements also were made by the State of Nevada Fish and Game Commission.

Table 17 summarizes monthly and annual streamflow at the three gaging stations. The record for the gage at Mountain City

Table 17.--Summary of streamflow, in cfs, at gaging stations in the Owyhee River Valley

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year
Owyhee River near Gold Creek, Nevada, for water years 1938-65													
Average	12.2	3.39	1.40	1.16	0.91	6.25	66.5	103	88.0	92.2	69.4	41.9	40.7
Max. month	42.3	15.3	9.12	14	14	100	549	500	148	404	158	104	[a] 88.0
Min. month	0	0	0	0	0	0	0	0	24.1	35.5	7.5	2.7	[b] 12.5
Owyhee River at Mountain City, Nevada, for water years 1938-48 (during regulation)													
Average	22.4	18.0	20.3	25.1	37.9	104	339	310	104	102	86.3	54.6	109
Max. month	50.6	28.1	61.8	109	107	224	1,035	788	336	143	162	97.0	[a] 211
Min. month	7.8	10.3	11	10	10	31.6	144	118	117	63.4	12.7	4.1	[b] 58.5
Owyhee River at Mountain City, Nevada, for water years 1928-37 (prior to regulation)													
Average	8.67	12.8	12.7	11.3	15.4	92.5	366	326	113	11.7	4.69	3.63	81.5
Max. month	17.4	30.5	34.9	25	32.3	408	852	563	225	23.5	12.0	11.2	[a] 144
Min. month	2.9	4.2	4	6	7	20	57.1	19.7	4.6	1.3	0	.5	[b] 15.6
Owyhee River above China diversion dam near Owyhee, Nevada, for water years 1940-65													
Average	28.0	24.6	33.1	38.1	68.6	108	399	467	261	118	72.8	50.2	139
Max. month	61.4	49.2	138	142	208	317	1,198	1,396	659	459	115	106	[a] 276
Min. month	12.8	8.35	10	10.6	14	26.2	80.9	103	98.7	41.3	12.3	5.3	[b] 53

a Maximum recorded water year.

b Minimum recorded water year.

is divided into two periods: before regulation (1928 through 1937) and after regulation (1938 through 1949) for comparison purposes. The data for the miscellaneous measurements are listed in table 18. The locations of the gaging stations and miscellaneous sites are shown on plate 1.

Characteristics of Streamflow

The data for the gaging stations listed in table 17 indicate that May has the largest monthly average streamflow at the gages near Gold Creek and near Owyhee but the largest monthly average streamflow was in April at the Mountain City gage for the reference periods of record.

Instantaneous peak flows have been recorded as:

Gage, near Gold Creek	1,810 cfs	May 5, 1922
Gage, at Mountain City	1,830 cfs	April 20, 1936
Gage, near Owyhee	2,710 cfs	May 3 (or 4), 1952

Periods of no flow have been recorded many times at the gage near Gold Creek, and in 1931 and 1934 at the gage at Mountain City. However, the minimum flow for the 1940-65 period of record at the gage near Owyhee was 1.8 cfs on November 16, 1961.

Generally, then, the flow of the Owyhee River is quite variable but is greatest in the spring during the snowmelt period. The seasonal pattern of flow prior to regulation by Wild Horse Reservoir is graphically shown in figure 11 and is based on the period of record 1928-37. During the April to June period, about 82 percent of the discharge occurred during the 10 water years 1928-37, prior to regulation from Wild Horse Reservoir.

The graphs in figure 12 show the annual streamflow pattern for Owyhee River near Gold Creek, Owyhee River at Mountain City, and Owyhee River above China diversion dam near Owyhee for the period since regulation by Wild Horse Reservoir. The graphs show that regulation has increased the July to September flow of the river below the reservoir. Based on the records of the gage at Mountain City, the July through September flow represented about 2 percent of the average annual flow for the period 1928-37. However, after regulation, the July through September flow represented about 18 percent of the average annual flow for the period 1938-48.

Estimated Runoff

Table 19 shows that the estimated average annual runoff, based on runoff-altitude relations in the Owyhee River Valley is roughly 120,000 acre-feet per year. About 52,000 acre-feet,

Table 18.--Miscellaneous streamflow measurements made in the Owyhee River Valley

Stream name	Location[1/]	Map no.	Date	Discharge (cfs)
Owyhee River	41/55-8	1	7- 6-66	0.00
Do.	43/55-4	2	7- 6-66	.09
Deep Creek	43/54-20	3	7-12-57	.62*
Do.	43/54-21	4	7-12-57	.09*
Do.	43/54-14	5	7-12-57	2.44*
Do.	do.		7- 6-66	.20
Martin Creek	44/56-18	6	7-17-53	2.07*
Penrod Creek	44/55-24	7	7-17-53	2.10*
Do.	44/55-28	8	7-18-53	1.98*
Do.	44/55-32	9	7- 6-66	.18
Beaver Creek	44/54-27	10	11- 4-53	1.88*
Do.	44/54-23	11	7- 6-66	.21
Badger Creek	44/53-5	12	10-10-53	.86*
Allegany Creek	45/55-18	13	7-14-53	.34*
Do.	45/54-29	14	7-14-53	.90*
Trail Creek	44/53-16	15	7- 7-66	1.09
Hutch Creek	44/53-16	16	7- 7-66	.20
California Creek	46/54-35	17	7-21-53	.56*
Do.	46/54-21	18	7-23-53	.40*
Do.	45/54-5	19	7-23-53	1.00*
Do.	45/53-1	20	7- 6-66	1.50
Slaughterhouse Creek	46/53-26	21	7- 6-66	.05 E
Skull Creek	46/53-6	22	7- 6-66	.62
Owyhee River	47/52-9	23	7- 6-66	13.0
Thacker Slough	(a)	24	7- 6-66	1.09
Billy Shaw Slough	(b)	25	7- 6-66	0

1. Locations are given in order by township, range, and section. Thus, location 41/55-8 is Township 41 North, Range 55 East, section 8 of the Mount Diablo base line and meridian, except as otherwise noted.

* Furnished by the State of Nevada Fish and Game Commission.

E Estimated.

a About 0.9 mile north of State line.

b At State line.

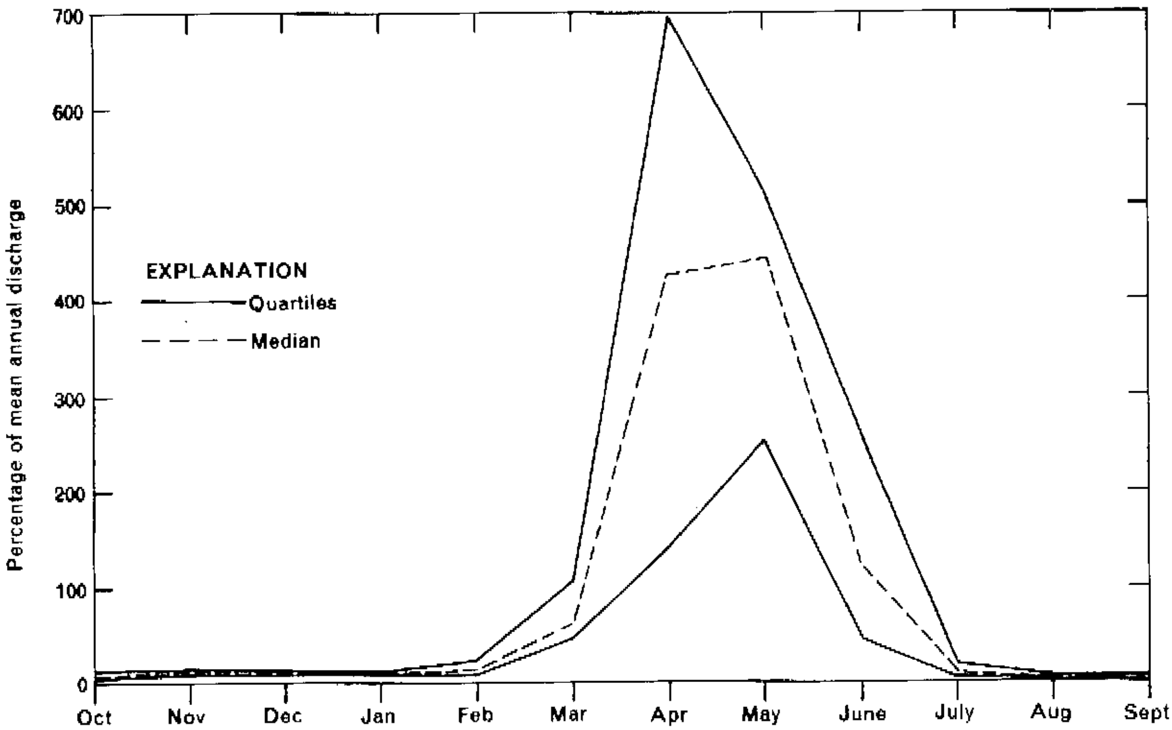


Figure 11.—Graph of monthly discharge as a percentage of mean annual discharge of the Owyhee River at Mountain City, Nevada prior to regulation (1928-37).

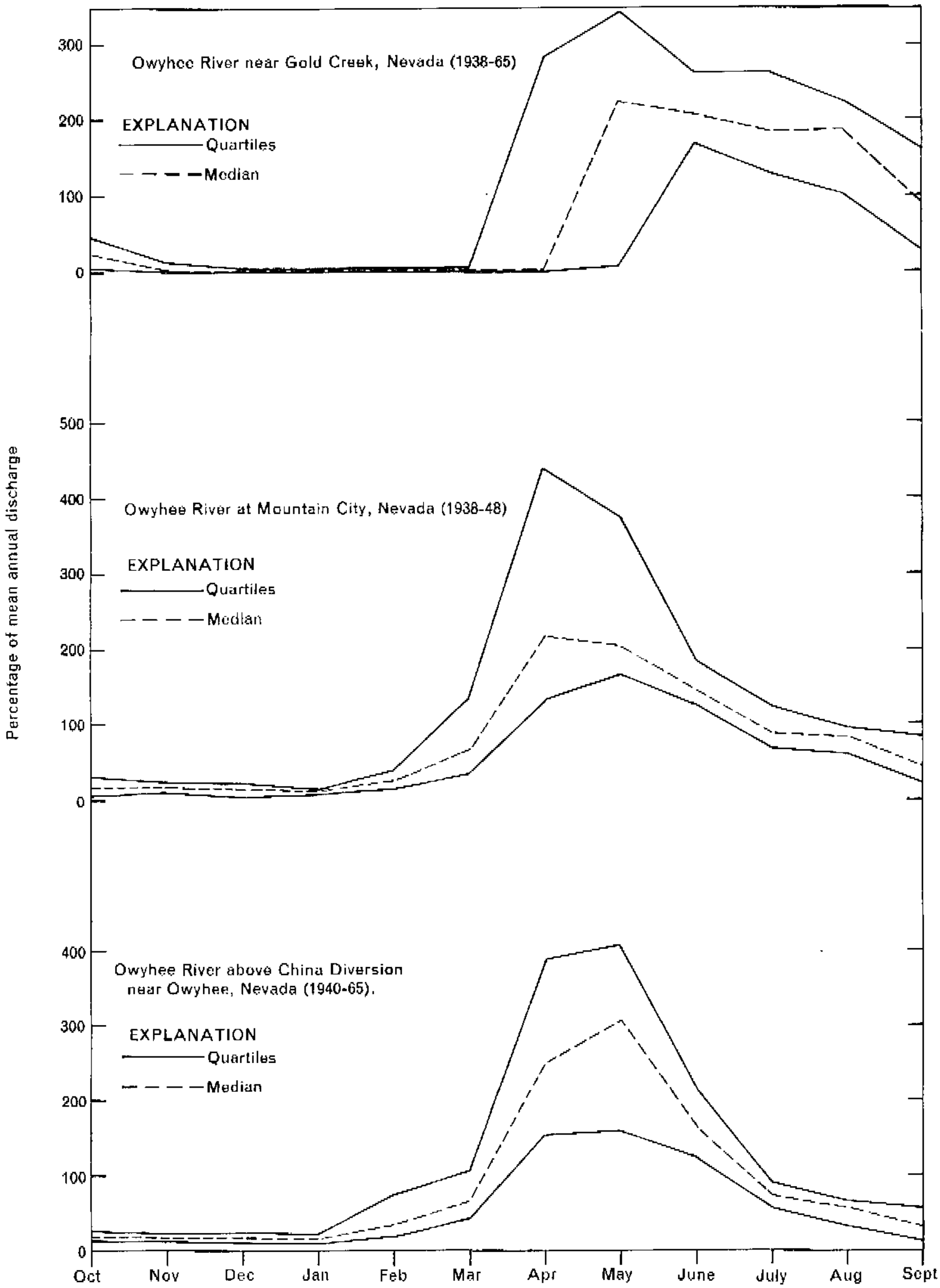


Figure 12.—Graphs of monthly discharge as a percentage of mean annual discharge of the Owyhee River

Table 19.--Estimated average annual runoff in Owyhee River Valley

(Runoff values rounded to two figures)

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Area west of Owyhee River draining Independence Mountains	158,200	48	52,000	45
Area east of Owyhee River	173,100	52	64,000	55
Total	331,300	100	120,000	100

or 45 percent of the total runoff, is supplied from the area west of the Owyhee River, and about 64,000 acre-feet, or 55 percent, is supplied from the area east of the Owyhee River.

Inflow and Outflow

No appreciable inflow occurs from Idaho into the Nevada part of Owyhee Valley. Blue Creek, which drains from the north, joins Owyhee River about 5 miles north of the State line. The main part of the outflow to Idaho in Duck Valley occurs in the main channel of the Owyhee River and the Main Canal. Small amounts discharge through Thacker Slough and Billy Shaw Slough. Ground water rises in the lower parts of Duck Valley in the vicinity of the State line and possibly elsewhere. Much of the low flow in Thacker Slough is from rising ground water.

The estimate of average annual outflow, based on measurements of channel geometry are: main channel Owyhee River, 80,000 acre-feet; Main Canal, 19,000 acre-feet; Thacker Slough, 800 acre-feet; and Billy Shaw Slough, 100 acre-feet. The several estimates are considered reasonable indicators of the magnitude of flow except that for the Main Canal. Measurements for the Main Canal probably give too large a value when correlated to an annual amount. This results, in part, because during the period of use the flow would tend to be relatively stable and the channel form would reflect this feature, but for part of the year no flow would be routed through the canal.

Provisionally, the average annual outflow through the canal may be roughly 9,000 acre-feet. Thus, the combined outflow from Nevada is estimated to be about 90,000 acre-feet per year.

South Fork Owyhee River Valley

Drainage

The South Fork Owyhee River Valley is a northwest-trending valley in the west half of the Snake River basin in Nevada. Independence Valley in the southern third of the area has mountains bordering a relatively wide valley floor. The northern two-thirds of the valley is a relatively flat tableland with streams in deep coulees. The South Fork Owyhee River originates in the southern end of the valley and flows northwest out of the State. Bull Run and Deep Creeks, the largest tributaries, flow into the South Fork Owyhee River above Chimney Creek and increase the flow of the river. Below Chimney Creek, evapotranspiration reduces the flow somewhat in the South Fork Owyhee River. Most of the tributaries south of Bull Run Creek are perennial. Several of the tributaries have reservoirs or stock ponds on them. The principal reservoirs are: Sheep Creek, Chimney Creek, Wilson Creek (capacity, 10,468 acre-feet), Rawhide (capacity, 1,540 acre-feet), Bull Run (capacity, 1,246 acre-feet), and Deep Creek (capacity, 940 acre-feet).

Records Available

The South Fork Owyhee River currently is gaged at two sites on the main stem. The gage at the upstream site, South Fork Owyhee River at Spanish Ranch near Tuscarora, is in NW¼NW¼ sec. 30, T. 41 N., R. 52 E., at a point about 0.2 mile downstream from Hot Creek. The gage was installed in August 1959 and streamflow records have been continuous to the present time.

The gage at the downstream site, South Fork Owyhee River near Whiterock, is in NE¼ sec. 16, T. 45 N., R. 49 E., 500 feet downstream from Rye Grass Creek. The gage was installed in October 1955 and streamflow records have been continuous to the present time.

A short partial record of South Fork Owyhee River (South Fork Owyhee River near Deep Creek) was obtained between May 1921 and December 1923, and from April to September 1924 at a site in NW¼ sec. 29, T. 42 N., R. 50 E., about ½-mile downstream from Red Cow Creek.

A short seasonal record of South Fork Owyhee River streamflow (South Fork Owyhee River near Tuscarora) was obtained from May to November 1913 in sec. 28, T. 40 N., R. 52 E., about 2 miles upstream from Taylor Creek.

Jack Creek, a tributary to the South Fork Owyhee River currently is gaged at a site in the NW¼SE¼ sec. 25, T. 42 N., R. 52 E., about a quarter of a mile below Schoonover Creek. This gage (Jack Creek below Schoonover Creek, near Tuscarora) was installed July 1962 and streamflow records have been continuous to the present time. Twelve years (June 1913 to June 1925) of streamflow record was obtained on Jack Creek (Jack Creek near Tuscarora) at a site in sec. 35, T. 42 N., R. 52 E., about 2 miles below the present gage site and 8 miles upstream from South Fork Owyhee River.

During the present investigation, miscellaneous measurements of streamflow were made on most of the tributaries to the South Fork Owyhee River and also on the main stem. Miscellaneous streamflow measurements also have been made by the State of Nevada Fish and Game Commission.

Table 20 summarizes the monthly and annual streamflow of the South Fork Owyhee River at two sites, "at Spanish Ranch" and "near Whiterock" for the respective periods of record. The data for the miscellaneous measurements are shown in table 21. Gaging stations and miscellaneous measurement sites are shown on plate 1.

Characteristics of Streamflow

The data in table 20 and the graphs in figure 13 indicate that the streamflow in the South Fork Owyhee River Valley occurs principally in the spring and is derived mainly from snowmelt. The record for South Fork Owyhee River near Whiterock indicates that more than 70 percent of the annual discharge occurred during the 4-month period March to June in 8 of 10 water years (1956-65). The other 2 years had high discharge in February. Similarly, 68 percent or more of the annual discharge of South Fork Owyhee River at Spanish Ranch near Tuscarora occurred during the 4-month period March to June in 5 of 6 water years (1960-65). A large portion of the discharge can occur during a single month. For example, the discharge for June 1963 at Spanish Ranch was 49 percent of the annual discharge and the discharge for June 1963 near Whiterock was 55 percent of the annual discharge.

For South Fork Owyhee River near Whiterock the instantaneous peak flow was 3,830 cfs on June 5, 1963. For South Fork Owyhee River at Spanish Ranch the instantaneous peak flow was 4,130 cfs on February 10, 1962. Low flow at the two gaging sites generally spans a period of 4 or 5 months beginning with August. No flow has occurred at the Whiterock gage during October 1-12, 1955 and September 17 and 28, 1960. The instantaneous minimum flow at the gage at Spanish Ranch of 0.4 cfs occurred on August 22 and 23, 1960.

Estimated Runoff

The average annual runoff estimated by use of runoff-altitude relations in the South Fork Owyhee River Valley is 140,000 acre-feet. Table 22 summarizes the runoff for different areas.

Inflow and Outflow

Nearly all the outflow from Nevada occurs in the main channel of the South Fork Owyhee River. The other outflow and the inflow is small and may be considered negligible. The total outflow near the State line, based on the geometry of the channel, was computed as about 100,000 acre-feet per year.

Table 20.--Summary of streamflow, in cfs, at gaging stations in South Fork Owyhee River Valley

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year
South Fork Owyhee River near Whiterock, Nevada, for water years 1956-65													
Average	20.0	35.8	50.1	74.2	163	195	396	485	332	51.9	17.0	15.8	152
Max. month	39.4	58.3	127	210	384	354	790	1,282	1,041	104	38.8	51.8	[a]265
Min. month	2.78	10.3	18	22	61.4	47.8	57.9	25.6	16.4	6.90	2.39	1.39	[b]32.6
South Fork Owyhee River at Spanish Springs Ranch near Tuscarora, Nevada, for water years 1960-65													
Average	14.6	19.2	19.4	22.6	70.5	56.2	132	150	156	41.1	20.3	14.7	59.4
Max. month	20.3	24.9	34.4	52.7	202	107	284	295	339	64.8	28.9	31.0	[a]105
Min. month	11.2	14.0	14.1	13.7	16.0	23.6	14.6	19.8	29.2	15.2	3.95	3.76	[b]16.6

a Maximum recorded water year.

b Minimum recorded water year.

Table 21.--Miscellaneous streamflow measurements made in South Fork Owyhee River Valley

Stream name	Location[1/]	Map no.	Date	Discharge (cfs)
McCann Creek	39/51-7	26	7- 9-66	0.26
Do.	39/51-8	27	7- 8-56	.93*
Water Pipe Canyon	39/53-19	28	6-22-54	1.60*
Taylor Canyon	39/52-23	29	7- 7-66	.53
Six Mile Canyon	40/51-24	30	7- 9-66	.07
Burns Creek	40/53-19	31	6-28-56	.61*
Do.	do.	32	7- 7-66	.71
Chicken Creek	42/53-30	33	7-12-57	6.81*
Do.	do.		9-26-57	.61*
Boyd Creek	42/53-30	34	7-12-57	.09*
Marsh Creek	41/52-2	35	6-25-66	6.90*
Do.	do.	36	7- 7-66	.14
Hot Creek	41/52-20	37	7- 9-66	.91
Deep Creek	42/52-1	38	7-12-57	.62*
Do.	do.		9-12-57	.58*
Do.	42/52-5	39	7-12-57	.09*
Do.	do.		7- 7-66	.54
Do.	42/51-11	40	7-12-57	2.44*
Do.	do.		9-27-57	.06*
Cap Winn Creek	43/53-7	41	7-17-57	2.89*
Do.	do.		9-27-57	1.72*
Blue Jacket Creek	44/52-27	42	7-18-57	4.92*
Do.	do.		9-27-57	.81*
Do.	44/52-23	43	7-18-57	2.42*
Columbia Creek	43/52-2	44	7- 7-66	3.58
Bull Run	43/52-14	45	7-17-57	.94*
Frost Creek	43/53-30	46	7-18-58	.87*
Do.	43/52-23	47	7-17-57	1.72*
Do.	do.		9-27-57	.54*
Bull Run	43/52-15	48	7-13-57	22.3*
Do.	do.		7- 7-66	2.42
Do.	43/52-6	49	7-13-57	21.3*
Do.	do.		9-27-57	3.79*
Dunn Canyon	44/52-18	50	7- 7-66	2.03
Silver Creek	44/51-1	51	7- 7-66	.43
S.F. Owyhee River	47/51-23	52	7- 8-66	10.5

1. Locations are given in order by township, range, and section. Thus, location 39/51-7 is T. 39 N., R. 51 E., sec. 7 of the Mount Diablo base line and meridian.

* Furnished by State of Nevada Fish and Game Commission

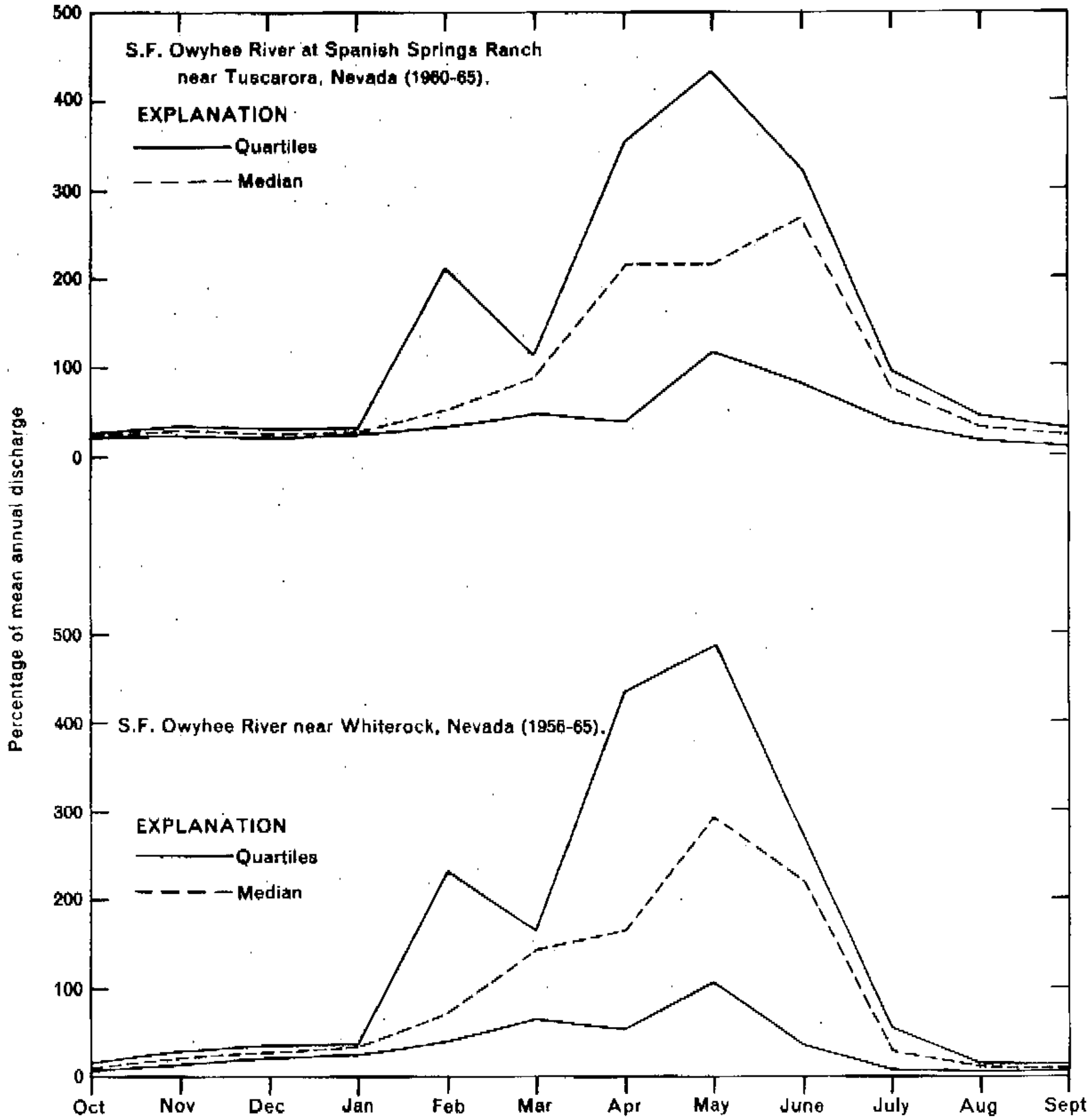


Figure 13.—Graphs of monthly discharge as a percentage of mean annual discharge of the South Fork of the Owyhee River.

Table 22.--Estimated average annual runoff in South Fork Owyhee River Valley

(Runoff values rounded to two figures)

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Area of the Independence Mountains north of Deep Creek, above 6,000-foot altitude	86,300	9	36,000	26
Area of the Independence Mountains east of South Fork Owyhee River and south of Deep Creek	196,500	20	53,000	39
Tuscarora Mountains upstream from Red Cow Creek	121,200	12	44,000	32
North of Red Cow Creek and Deep Creek, below 6,000 feet	602,000	59	3,600	3
Total (rounded)	1,006,000	100	140,000	100

East Little Owyhee River Valley

Drainage

The East Little Owyhee River Valley is a north-trending valley on the western end of the Snake River basin in Nevada. The upland of the valley is relatively flat with the streams in deep canyons with vertical cliffs. The west side of the valley is formed by a part of the Santa Rosa Range. The main stream in the valley is the East Little Owyhee River which originates on the southwest part of the valley and flows out of Nevada in the northeast corner. Several tributaries, the two largest are Lake Creek and Raven Creek, flow into the East Little Owyhee River. The streams are ephemeral in the valley, except the intermittent upper reaches of those draining the Santa Rosa Range. Most of the streams have several stock ponds.

Records Available

No gaged streamflow records are available in the East Little Owyhee River Valley. During the present investigation, miscellaneous measurements of streamflow were made on Raven Creek, Lake Creek, and East Little Owyhee River. Data for the miscellaneous measurement sites are listed in table 23 and locations shown on plate 1.

Characteristics of Streamflow

The streamflow in the East Little Owyhee River Valley is very erratic with respect to time and amount. Most of the streams on the west side of the valley draining from the Santa Rosa Range flow at times each year during the spring snowmelt and after heavy thunderstorms. Elsewhere, streamflow has even shorter duration.

Estimated Runoff

The average annual runoff in the East Little Owyhee River Valley, based on runoff-altitude relations, is estimated to be 17,000 acre-feet. It is estimated that 88 percent of the runoff is supplied from the Santa Rosa Range which represents only 12 percent of the area of the valley. The estimated average annual runoff is summarized in table 24.

Inflow and Outflow

There is no appreciable inflow from Idaho into the Nevada part of the East Little Owyhee River Valley. The only appreciable outflow from Nevada occurs in the stream channel of the East Little

Table 23.--Miscellaneous streamflow measurements in East Little Owyhee River Valley

Stream name	Location[1]	Map no.	Date	Discharge (cfs)
East Little Owyhee River	45/43-28	53	7- 8-66	0.76
East Little Owyhee River	46/45-20	54	7- 8-66	0
Lake Creek	46/46-20	55	7- 8-66	0
Unnamed tributary	46/43-20	56	7- 8-66	0
East Little Owyhee River	47/47-23	57	7- 8-66	0
Raven Creek	46/43-20	58	7- 8-66	.08 E
Raven Creek	47/44-23	59	7- 8-66	0

1. Locations are given in order by township, range, and section. Thus, location 45/43-28 is T. 45 N., R. 43 E., sec. 28 of the Mount Diablo base line and meridian.

E. Estimated.

Table 24.--Estimated average annual runoff in East Little Owyhee River Valley

Location	Area		Estimated runoff	
	Acres	(Percent of runoff area)	(Acre-feet per year)	(Percent of total runoff)
Area of the Santa Rosa Range, above 6,000 feet	52,760	12	15,000	88
Remaining area below 6,000 feet	399,500	88	2,000	12
Total (rounded)	452,300	100	17,000	100

Owyhee River. The outflow, based on channel geometry, from the East Little Owyhee River Valley is estimated to be about 6,000 acre-feet per year.

Summary of Surface Water

The runoff in the Snake River basin in Nevada is summarized by principal valleys in table 25. Of the 680,000 acre-feet of average annual runoff estimated to be generated in Nevada, about 500,000 acre-feet or 74 percent leaves the State as streamflow. Additionally, about 17,000 acre-feet of streamflow comes into Nevada from Idaho drainage areas. The combined streamflow from Nevada to Idaho is estimated to be about 510,000 acre-feet a year.

Table 25.--Summary of estimated runoff, inflow, and outflow for the Snake River basin in Nevada

(Values, in thousands of acre-feet, rounded to two figures)

Valley	Estimated inflow from Idaho (1)	Estimated outflow from Nevada (2)	Estimated net outflow from Nevada (3)=(2)-(1)	Estimated runoff generated in Nevada
Goose Creek	7	30	23	52
Salmon Falls Creek	10	98	88	140
Bruneau River	--	96	96	110
Jarbidge River	--	93	93	98
Owyhee River	--	90	90	120
South Fork Owyhee River	--	100	100	140
East Little Owyhee River	--	6	6	17
Total (rounded)	17	510	500	680

HYDROLOGIC BUDGET

The hydrologic budget for the Snake River basin in Nevada can be given in general terms. The surface-water part is nearly complete but data are not available to describe fully the ground-water part. This is closely related to the facts that: the streams generally are in deeply incised canyons; and streamflow and ground water are interrelated to such an extent that the flood-plain areas alternately function as areas in which the streams recharge the ground-water reservoirs and ground water discharges to the streams, depending on the relative stages of the streams. Thus, during periods in which ground-water levels are high, surface water may be rejected from the ground-water system that otherwise would be potential recharge.

Evapotranspiration in the flood plains removes water derived from direct precipitation, surface water, and ground water, according to availability. The losses by evapotranspiration have been estimated and proportioned between surface-water and ground-water sources. The amount of ground water discharging to the streams and thence flowing out of Nevada has not been determined but is considered to be on the order of 10 percent of the total stream outflow.

Table 26 summarizes some of the inflow and outflow components of the hydrologic system. Only the overall relation between inflow and outflow can be given as neither the complete surface-water nor the ground-water system can be fully defined by available estimates. Thus, the sum of inflow components (1) and (2) equals the sum of outflow components (5), (6), (8), (9), and (10). Values for several of the components are obtained by difference, thus the apparant balance between inflow and outflow is not significant. However, the various estimates are considered to be reasonable and indicate the proportionate distribution of water within the hydrologic system of the Snake River basin in Nevada.

Comparing stream outflow from Nevada to runoff generated in Nevada as a percentage gives these values for the several valleys: Bruneau-Jarbidge, 93; Owyhee River, 86; South Fork Owyhee, 74; Salmon Falls Creek, 64; Goose Creek, 51; and East Little Owyhee, 35. The indicated trend generally illustrates the relative effectiveness of the respective valleys in transmitting runoff out of the area as streamflow. Thus, the Bruneau-Jarbidge stream system is the most efficient of the several valleys for transmitting runoff out of the valley as streamflow; and East Little Owyhee River probably is the least efficient.

Table 26.--Summary of estimates of some components of the hydrologic system

(Values, in thousands of acre-feet, rounded to two figures)

	Goose Creek Valley	Salmon Falls Creek Valley	Bruneau River Valley	Jarbidge River Valley	Owyhee River Valley	South Fork Owyhee River Valley	East Little Owyhee River Valley	Snake River basin in Nevada (sum)
INFLOW:								
(1) Precipitation (table 3)	200	1,020	500	330	460	1,000	360	3,900
(2) Streamflow from Idaho (table 26)	7	10	--	--	--	--	--	17
(3) Runoff (table 26)	52	140	110	98	120	140	17	680
(4) Potential recharge to ground water (p. 26)	6.7	43	23	23	18	30	2.1	150
OUTFLOW:								
(5) Streamflow from Nevada (table 26)	30	98	96	93	90	100	6.0	510
(6) Evapotranspiration of surface water (table 4)	3.0	20	5.9	small	18	50	--	97
(7) Ground-water discharge to streams (10 percent of streamflow value and included in it)	(3)	(9.8)	(9.6)	(9.3)	(10)	(10)	--	(51)
(8) Evapotranspiration from ground water (table 4)	1.7	10	3.2	small	7.1	23	--	46
(9) Ground-water underflow (p. 28)	small	small	small to moderate	small to moderate	small	small	small	small
(10) Evapotranspiration from precipitation (obtained by difference): total precipitation minus outflow and evapotranspiration from surface water and ground water	170	890	400	240	340	830	350	3,200

Perennial Yield

The perennial yield of a ground-water system may be taken as the amount of water that can be withdrawn from the system for an indefinite period of time without causing continuing depletion of storage or a deterioration of water quality beyond the limits of economic recovery. Economic feasibility involves factors other than the physical factors of the hydrologic system. Based on the hydrologic system, the perennial yield may be taken as the quantity of water equivalent to the average natural recharge to or discharge from the system.

On this premise, and using estimated ground-water discharge to streams and by evapotranspiration values shown in table 26, the perennial yield of the basin would be nearly 100,000 acre-feet. However, if the development were favorably located, lowering of water levels due to pumping would result in inducing additional recharge that is now being rejected. In this case, the perennial yield would be larger, possibly approaching the estimated potential recharge of about 150,000 acre-feet. Further development along the flood plains of the principal streams could induce even more recharge which would be supplied from what is now entirely streamflow. It is evident, of course, that the potential for a larger sustained ground-water yield could be increased through development, but large-scale development along the flood plains also could significantly affect streamflow and existing water rights. The rapidity and magnitude of the effect is largely dependent upon the relative distance and distribution of wells with respect to the streams and natural discharge areas. Spacing between wells and the pattern of pumping also could significantly affect streamflow.

Provisionally, then, it should be possible to develop a perennial yield of nearly 50,000 (46,000) acre-feet by salvaging ground water now discharged by evapotranspiration. Areas in which ground-water discharge by evapotranspiration could be most effectively salvaged by pumping would be in the larger lowland areas of Independence, Duck, and lower Salmon Falls Creek Valleys. Cyclic or seasonal withdrawals from wells one-half to several miles from the main streams would have minimum effects on streamflow. Withdrawals equivalent to the estimated ground-water discharge by evapotranspiration, that is, about 15,000, 3,600, and 7,400 acre-feet a year, respectively, for Independence, Duck, and lower Salmon Falls Creek Valleys, probably could be sustained with little effect on streamflow from appropriately spaced wells. Similarly, smaller amounts of ground-water evapotranspiration losses could be salvaged along the wider flood-plain segments of the principal streams in the remaining parts of South Fork Owyhee River, upper Owyhee River, upper

Bruneau River, upper Salmon Falls Creek, and Goose Creek Valleys.

Withdrawals much in excess of the 50,000 acre-feet a year of ground water discharged by evapotranspiration in these areas would tend to decrease streamflow, but if such were desired, could prove useful in partially regulating the amount of water, either surface or ground water, available through the year. The ground-water reservoir can function much in the manner of a surface-water reservoir but with a less rapid effect on the flow system.

CHEMICAL QUALITY

The analyses of 26 samples of water, listed in table 27, provide some information on the chemical quality of water in the Snake River basin in Nevada. These few samples, of course, cannot be expected to fully represent the quality of water throughout the basin, particularly for ground water which is subject to wide variations depending upon the rocks through which it is moving and the relative position in the particular ground-water flow system from which the sample was taken.

According to the U.S. Department of Agriculture Salinity Laboratory Staff (1954, p. 69), the most significant factors in the chemical suitability of water for irrigation are dissolved-solids content, the relative proportion of sodium to calcium and magnesium, and the concentration of elements and compounds that are toxic to plants. Dissolved-solids content commonly is expressed as "salinity hazard," and the relative proportion of sodium to calcium and magnesium as "alkali hazard." The Salinity Laboratory Staff suggests that salinity and alkali hazards should be given first considerations in appraising the suitability of water for irrigation, then consideration should be given to boron, other toxic elements, and bicarbonate, any one of which may change the quality rating.

Table 27 indicates the determined or computed values for several of the chemical constituents. Most of the analyses indicate the water to be of medium salinity hazard and low alkali hazard. The reported values for RSC (residual sodium carbonate) are well below the marginal values of 1.25 to 1.50, which are reported to be unsuitable for irrigation (Eaton, 1950). Only four samples were analyzed for boron. The concentration of 0.1 part per million (0.1 milligram per liter) or less reported is below the lesser limit of adverse effect from boron according to Scofield (1936).

Most of the analyses indicate that the water is hard. However, the headwater streams, and recharge areas for ground water, commonly would yield water of low dissolved solids and hardness, such as is indicated by the analysis for water from well 46/58-21bc1. Of the five analyses in which fluoride was determined, the highest value was 0.6 ppm (parts per million) (or 0.6 milligram per liter) for the sample from well 46/69-15ab1. This is below the upper limit for fluoride suggested by the U.S. Public Health Service (1962) for drinking water standards.

The several analyses show that considerable variation in particular chemical constituents, occurs within the basin.

Table 27.--Partial and detailed chemical analyses of water from wells, springs, and streams

[Field-office and detailed analyses by the U.S. Geological Survey]

Location	Source	Date sampled	Temperature °F	Temperature °C	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) plus potassium (K)[3]	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Hardness as $CaCO_3$	Specific conductance (micromhos per cm at 25°C)	pH (lab. determination)	Salinity hazard	Sodium-adsorption ratio (SAR)	Sodium hazard	Residual sodium carbonate (RSC)
					Milligrams per liter (upper number) and milliequivalents per liter (lower number)[1]										Factors affecting suitability for irrigation[2]			
NEVADA																		
39/51-13da	Well	8-10-67	--	--	36 1.80	7.8 0.64	19 0.82	136 [illegible]	0 0.00	36 0.75	10 0.28	122 2.44	300	8.0	medium	0.7	low	S(0.00)
39/52-3cd	Hwy. Maintenance Station well	8-11-67	55	13	58 2.89	22 1.83	28 1.20	250 4.10	0 0.00	56 1.17	23 0.65	236 4.72	510	8.2	medium	0.8	low	S(0.00)
40/52-26ad	Van Norman well	8-10-67	62	17	44 2.20	23 1.86	11 0.49	230 3.77	0 0.00	30 0.62	5.8 0.16	203 4.06	380	[illegible]	medium	0.3	low	S(0.00)
41/48-1bd	Well	8-12-67	--	--	16 0.80	3.6 0.30	25 1.10	97 1.59	0 0.00	9.2 0.19	15 0.42	55 1.10	230	6.9	low	1.5	low	S(0.49)
41/52-32dc	Ellison Ranch - 2d Hay Camp well	8- 9-67	52	11	19 0.95	7.4 0.61	19 0.81	119 1.95	0 0.00	5.2 0.11	11 0.31	78 1.56	240	8.0	low	0.9	low	S(0.39)
41/56-14	P. Ticaini Ranch well	8- 8-67	50	10	9.6 0.50	3.4 0.28	18 0.78	64 1.05	0 0.00	13 0.27	8.4 0.24	39 0.78	130	7.8	low	1.2	low	S(0.27)
42/50-5bc[4]	U. Ranch - main well	8-12-67	61	16	59 2.94	12 0.99	(4)	224 4.08	12 0.40	46 0.96	35 0.99	196 3.93	600	8.6	medium	1.6	low	S(0.55)
43/50-16cc	U. Ranch - upper well	8-11-67	62	17	69 3.44	5.6 0.46	64 2.78	287 4.70	0 0.00	67 1.39	21 0.59	195 3.90	590	7.4	medium	2.0	low	S(0.80)
44/48-2dc	Desert Ranch - main well	8-12-67	51	11	50 2.50	12 0.98	59 2.55	301 4.93	0 0.00	34 0.71	14 0.39	174 3.48	520	7.2	medium	1.9	low	M(1.45)
44/50-6ba	YP Ranch - main well	8-13-67	59	15	129 6.44	24 1.95	25 1.07	366 6.00	0 0.00	115 2.39	38 1.07	420 8.39	800	7.9	high	0.5	low	S(0.00)
44/51-17bc	Well	8-13-67	--	--	42 2.10	23 1.88	13 0.56	248 4.06	0 0.00	6.6 0.14	12 0.34	199 3.98	400	7.7	medium	0.4	low	S(0.08)
44/51-18bd	Spring	8- 3-67	55	13	45 2.25	11 0.93	20 0.88	219 3.59	0 0.00	11 0.23	8.6 0.24	159 3.18	360	7.6	medium	0.7	low	S(0.41)
44/57-35bb	Old school house well	8- 8-67	56	13	14 0.70	3.2 0.26	23 0.98	97 1.59	0 0.00	5.8 0.12	8.0 0.23	48 0.96	200	7.7	low	1.4	low	S(0.63)
45/48-25cc	Desert Ranch - upper well	8-12-67	56	13	35 1.75	9.1 0.75	47 2.04	222 3.64	0 0.00	6.8 0.14	27 0.76	125 2.50	470	7.3	medium	1.8	low	S(1.14)
45/49-16aa[4]	South Fork Owyhee River	8-13-67	--	--	26 1.30	10 0.82	(4)	156 2.56	0 0.00	23 0.48	8.0 0.23	106 2.12	309	8.1	medium	1.0	low	S(0.44)
45/56-32ad	Gold Creek Ranger Station springs	8-14-67	67	19	51 2.54	5.1 0.42	10 0.44	193 3.16	0 0.00	5.2 0.11	4.6 0.13	148 2.96	300	7.7	medium	0.4	low	S(0.20)
46/51-29ca	Sheep Creek Reservation well	8-14-67	54	12	22 1.10	9.5 0.78	30 1.31	119 1.95	0 0.00	20 0.42	29 0.82	94 1.88	320	7.4	medium	1.4	low	S(0.07)
46/53-36bb	Mountain City Motel well	8-14-67	59	15	54 2.69	8.4 0.69	21 0.91	187 3.06	0 0.00	10 0.21	36 1.02	169 3.38	500	7.7	medium	0.7	low	S(0.00)
46/53-36c[4]	Test hole	6- -57	57	14	24 1.20	0 0.00	(4)	88 1.44	0 0.00	14 0.29	10 0.28	60 1.20	206	7.6	low	0.1	low	S(0.24)
46/58-21bc	Well	8- 8-67	51	11	6.4 0.32	0.7 0.06	9.4 0.41	32 0.52	0 0.00	8.0 0.17	3.6 0.10	19 0.38	68	7.7	low	0.9	low	S(0.14)
46/64-23bb[4]	San Jacinto Ranch spring	1-24-68	78	26	25 1.25	8.6 0.71	(4)	132 2.16	0 0.00	11 0.23	3.9 0.11	98 1.96	245	8.1	low	0.6	low	S(0.20)
46/69-2cd[4]	Well	9- 3-56	70	21	30 1.50	8.0 0.66	(4)	142 2.33	0 0.00	13 0.27	3.5 0.10	108 2.16	261	7.9	medium	0.4	low	S(0.17)
46/69-15ab[4]	Well	9- 3-56	110	43	16 0.80	5.7 0.47	(4)	118 1.93	1.0 0.03	22 0.46	2.0 0.06	64 1.27	242	8.3	low	0.1	low	S(1.00)
47/51-11ca	State line well	8-14-67	52	11	8.8 0.44	3.2 0.26	26 1.12	81 1.33	0 0.00	5.0 0.10	14 0.39	35 0.70	180	7.5	low	1.9	low	S(0.63)
47/52-26[4]	Owyhee River	9- 3-59	--	--	29 1.45	5.1 0.42	(4)	138 2.26	0 0.00	7.7 0.16	3.9 0.11	94 1.87	243	7.7	low	0.6	low	S(0.39)
47/52-26[4]	Owyhee River	4-26-60	--	--	17 0.85	2.8 0.23	(4)	70 1.15	0 0.00	8.2 0.17	2.1 0.06	54 1.08	131	7.8	low	0.3	low	S(0.07)
47/52-26aa	Well	8-14-67	54	12	40 2.00	10 0.82	32 1.40	211 3.46	0 0.00	25 0.52	8.6 0.24	141 2.82	300	7.4	medium	1.2	low	S(0.64)
47/52-35bc	Well	8-14-67	61	16	47 2.35	10 0.81	21 0.93	225 3.69	0 0.00	6.2 0.13	9.6 0.27	158 3.16	390	7.5	medium	0.7	low	S(0.53)
47/64-23a[4]	Shoshone Creek	1-24-68	49	9	29 1.45	6.5 0.53	(4)	141 2.31	0 0.00	16 0.33	4.2 0.12	94 1.98	259	8.1	medium	0.6	low	S(0.33)
47/64-23c[4]	Salmon Falls Creek	4-23-60	--	--	13 0.65	2.2 0.18	(4)	61 1.00	0 0.00	6.7 0.14	2.8 0.08	42 0.83	123	7.5	low	0.5	low	S(0.17)
47/64-23c[4]	Salmon Falls Creek	8- 2-60	--	--	27 1.35	6.3 0.52	(4)	126 2.07	4.0 0.13	13 0.27	5.7 0.16	91 1.87	243	8.4	low	0.7	low	S(0.33)
47/65-18ca[4]	Flowing well	1-24-68	100	38	37 1.85	8.6 0.71	(4)	184 3.02	0 0.00	20 0.42	1.8 0.05	128 2.56	332	7.9	medium	0.6	low	S(0.46)
IDAHO																		
16/7-16da[4]	Owyhee River	8-14-67	--	--	38 1.90	6.3 0.52	(4)	172 2.82	0 0.00	14 0.29	4.6 0.13	121 2.42	303	7.6	medium	0.7	low	S(0.40)
16/9-14dd[4]	East Fork Jarbidge River	9- 1-59	--	--	5.0 0.25	0.4 0.03	(4)	27 0.44	0 0.00	4.3 0.09	1.4 0.04	14 0.28	64	7.3	low	0.6	low	S(0.16)
16/9-14dd[4]	East Fork Jarbidge River	4-24-60	--	--	4.4 0.22	0.1 0.01	(4)	19 0.31	0 0.00	2.4 0.05	0.7 0.02	12 0.23	57	7.3	low	0.4	low	S(0.08)

1. Milligrams per liter and milliequivalents per liter are metric units of measure that are virtually identical to parts per million and equivalents per million, respectively, for all waters having a specific conductance less than about 10,000 micromhos. The metric system of measurement is receiving increased use throughout the United States because of its value as an international form of scientific communication. Therefore, the U.S. Geological Survey recently has adopted the system for reporting all water-quality data.

2. Salinity hazard is based on specific conductance (in micromhos) as follows: low, 0-250; medium, 251-750; high, 751-2,250; very high, >2,250. Sodium-adsorption ratio (SAR) provides an indication of what effect an irrigation water will have on soil-drainage characteristics. SAR is calculated as follows, using milliequivalents per liter: $SAR = Na/\sqrt{(Ca+Mg)/2}$. Sodium hazard is based on an empirical relation between salinity hazard and sodium-adsorption ratio. Residual sodium carbonate (expressed in milliequivalents per liter) is tentatively related to suitability for irrigation as follows: safe (S), 0-1.25; marginal (M), 1.26-2.50; unsuitable (U), >2.50. The several factors should be used as general indicators only, because the suitability of a water for irrigation also depends on climate, type of soil, drainage characteristics, plant type, and amount of water applied. These and other aspects of water quality for irrigation are discussed by the U.S. Salinity Laboratory Staff (1954).

3. Computed as the milliequivalent-per-liter difference between the determined negative and positive ions; expressed as sodium. Computation assumes that concentrations of undetermined ions--especially nitrate--are small.

4. Detailed laboratory analysis; additional determinations are listed below.

Table 27.--Continued

Additional determinations from detailed analyses

Location	Milligrams per liter (upper number) and milliequivalents per liter (lower number)[1]								Dissolved-solids content[2]
	Silica (SiO_2)	Iron (Fe)	Sodium (Na)	Potassium (K)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Boron (B)	
NEVADA									
42/50-5bc	--	--	50 2.18	9.6 0.25	--	--	--	--	--
45/49-16aa	10	0.01	23 1.00	4.3 0.11	0.4 0.02	0.4 0.01	--	0.1	182
46/53-36c	62	--	18 0.78	2.8 0.07	0.3 0.02	1.1 0.02	0.30	--	175
46/64-23bb	18	0.00	13 0.57	3.9 0.10	0.5 0.03	0.1 0.00	.00	0.0	149
46/69-2cd	27	0.06	8.5 0.37	5.4 0.14	0.4 0.02	.0 0.00	.00	--	166
46/69-15ab	21	0.18	24 1.04	5.6 0.14	0.6 0.03	.0 0.00	.00	--	157
47/52-26	25	--	13 0.57	3.9 0.10	0.6 0.03	.0 0.00	--	--	156
47/52-26	24	--	5.3 0.23	1.6 0.04	0.2 0.01	.0 0.00	--	--	95
47/64-23a	32	0.25	14 0.61	5.5 0.14	0.5 0.03	0.1 0.00	.00	0.0	179
47/64-23c	33	--	6.9 0.30	3.9 0.10	0.4 0.02	.0 0.00	--	--	99
47/64-23c	45	--	15 0.65	7.8 0.20	0.4 0.02	.0 0.00	--	--	186
47/65-18cb	20	--	17 0.74	8.4 0.21	0.7 0.04	0.8 0.01	.01	0.0	205
IDAHO									
16/2-16da	24	0.14	17 0.74	4.2 0.11	0.4 0.02	0.2 0.00	--	0.1	194
16/9-14dd	26	--	5.3 0.23	2.3 0.06	0.4 0.02	.0 0.00	--	--	58
16/9-14dd	23	--	3.0 0.13	1.6 0.04	0.4 0.02	.0 0.00	--	--	45

1. See footnote 1, above. Where only one number is shown, the number is milligrams per liter.

2. Calculated, with HCO_3 expressed as CO_3.

Generally, concentrations are moderate to low and this is consistent with the fact that much of the runoff leaves the basin as streamflow. The free and rapid circulation of runoff through and out of the Snake River basin tends to remove dissolved constituents from the area rather than letting them accumulate as a residual of evapotranspiration losses.

Similarly, ground-water circulation is relatively free. Much of the ground water is discharged by evapotranspiration in the flood plains, from which residual salts are removed by periodic flooding of the area. Additionally, a considerable part of the ground water is discharged to the streams which in turn carry dissolved constituents from the basin. Thus, the general nature of the hydrologic system tends to maintain moderate to low concentrations of chemical constituents in the basin. However, water locally may have high concentrations of chemical constituents in areas where rocks may be readily soluble or in areas where the discharge can only be by evapotranspiration.

USE OF WATER

Most of the available surface water leaves Nevada as streamflow. As previously estimated, roughly 500,000 acre-feet of streamflow a year leaves the State (table 25). A much smaller amount is used within Nevada for irrigation of cultivated crops, hay and pasture, and native meadows. Ordinarily, use in Nevada probably is on the order of 100,000 acre-feet a year, though the quantity can vary considerably depending on available supplies.

Availability of water from the main streams has been improved by the construction of reservoirs. The principal reservoirs on the Owyhee River, Salmon Falls Creek, and Goose Creek are downstream from the Nevada State line. The Bruneau River enters the Snake River only a short distance upstream from the C. J. Strike Reservoir in Idaho. Within Nevada, Wild Horse Reservoir (capacity, 32,690 acre-feet) on the Owyhee River upstream from Mountain City is the largest. The Wild Horse dam currently is being replaced and reservoir capacity will be increased to about 70,000 acre-feet. Other reservoirs include: Wilson Creek Reservoir (capacity, 10,468 acre-feet) which receives water from Wilson and Bull Run Creeks; Rawhide (capacity, 1,540 acre-feet) and Bull Run (capacity, 1,246 acre-feet) Reservoirs, on Bull Run Creek; Deep Creek Reservoir (capacity, 940 acre-feet), is on Deep Creek; IL Reservoir, on the South Fork Owyhee River; Sheep Creek Reservoir, on Sheep Creek; and Charleston Reservoir, on Bruneau River.

The flood-plain segments of lower Bull Run Creek, its tributaries, and the South Fork Owyhee River downstream from Red Cow Creek have been substantially improved for irrigation by leveling, and installation of distribution and drainage systems. Elsewhere, improvements for surface-water irrigation generally are less extensive, and for much of the native meadow areas, irrigation improvements have been quite limited.

Ground water has not been developed by wells to any large extent in the Nevada part of Snake River basin. Numerous wells have been drilled for stock and domestic use as indicated by the wells listed in table 28. Several wells provide public supplies for Jackpot. Many domestic wells have been drilled recently in Duck Valley near Owyhee. Elsewhere, wells generally are scattered. The amount of water supplied by wells for domestic and stock purposes probably is no more than a few hundred acre-feet a year.

Only a few large capacity wells have been developed in the area. Of several wells drilled for irrigation supplies in southern Independence Valley, apparently only two currently are being used. Well 40/52-26ad1, which reportedly yields about 950 gallons a minute, is used regularly for irrigation partly to supplement surface-water supplies. Well 39/52-4ad1, which is used less, was test pumped at 1,500 gallons a minute with a 34-foot drawdown (Eakin, 1962, p. 18). In Goose Creek Valley two wells were drilled adjacent to spring areas in the valley lowland. Well 46/69-15ab1 flowed about 1,350 gallons a minute when completed in 1949. The flow rate has since reduced. In July 1967, the flow was estimated to be about 350 gallons a minute after the gate valve had been opened for a short time. Well 46/69-2cd1 initially flowed nearly 500 gallons a minute when drilled in 1954.

In the northern part of Salmon Falls Creek Valley, well 47/65-18bc1, north of Shoshone Creek, was completed in 1966. It reportedly is pumped at a rate of about 2,500 gallons a minute and is used for irrigation.

Recently well 47/65-18da1 was completed about three-quarters of a mile east of well 47/65-18bc1. The new well reportedly flows about 1,250 gallons a minute. South of Contact well 43/63-14ab, which reportedly yields 260 gallons a minute is used for supplemental irrigation. Thus, a few large capacity wells are distributed in four general areas of the Snake River basin in Nevada and these are used principally for supplemental irrigation. The wells in Independence Valley and the areas south of Contact are developed in valley-fill deposits (table 29). However, the wells in Goose Creek Valley apparently obtain their water from consolidated carbonate rocks and the log descriptions of the wells in northern Salmon Falls Creek Valley suggest that the water principally comes from volcanic rocks or associated sedimentary rocks.

Potential use: The degree to which additional surface water can be made available probably is controlled largely by the degree to which additional regulation might provide increased quantity when needed, with due regard to the various water rights. The current enlargement of the capacity of Wild Horse Reservoir is an example of additional regulation. It does not increase total supply but increases the availability when needed.

Additional ground water can be developed. On the premise of perennial yield, withdrawals could salvage the natural ground-water losses by evapotranspiration, 50,000 acre-feet a year. Wells appropriately located in and adjacent to natural discharge areas could effect the salvage with minimum effect on current streamflow. As previously indicated, the principal areas where this salvage can be accomplished are in the lowland or flood-plain areas of Independence, Duck, and lower Salmon Falls Creek Valleys, where perhaps 15,000, 3,600, and 7,400 acre-feet, respectively, could be salvaged. The remaining 19,000 acre-feet could be salvaged by more widely distributed wells in the wider flood-plain segments of other parts of the South Fork Owyhee River, upper Owyhee River, upper Bruneau River, upper Salmon Falls Creek, and Goose Creek Valleys. Locations of withdrawals and withdrawal rates should be carefully selected to minimize possible interference with streamflow.

DESIGNATION OF WELLS AND SPRINGS

The numbering system for wells and springs is based on the rectangular subdivision of public lands, and in Nevada is referenced to the Mount Diablo base line and meridian. The number consists of three units: the first is the township north of the base line; the second unit, separated from the first by a slant, is the range east of the meridian; and the third unit, separated from the second by a dash, designates the section number. The section number is followed by one or two letters. The first letter designates the quarter section. The letters a, b, c, and d respectively designate the northeast, northwest, southwest, and southeast quarter sections. In a similar manner, the second letter designates the quarter-quarter section. For example, well 40/52-26 ad1 is the first well recorded in the southeast quarter of the northeast quarter, sec. 26, T. 40 N., R. 52 E., Mount Diablo base line and meridian. One or two locations are in Idaho. These are identified by an "S" after the township number and indicates the township south of the Boise base line. The range number is east of the Boise meridian.

Table 28.--Records of selected wells

Use: D, domestic; I, irrigation; S, stock; HC, highway construction; U, unused; RR, railroad; PS, public supply; FP, fire protection

Water-level measurement: Des, destroyed; UTM, unable to measure

State log number: Number is the log number in the files of the Nevada State Engineer

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
39/51-11bc1	Simco, Inc.	--	860	12	I	250/15	--	7-25-67	3.78	1909
-13da1	Quarter Circle S Ranch	--	21.5	4'x 4'	D	--	--	8-10-67	13.51	--
-26bb1	Willis Packer	1960	430	16	I	400/--	--	8-10-67	3.24	--
-26dd2	Willis Packer	--	11	4'x 4'	D,S	--	--	8-10-67	5.14	--
39/52-3cd1	State Hwy. Dept.	1958	172	6	D	18/4	--	8-11-67	118.69	5568, 4374
-4ad1	C. Van Norman	1960-62	450	16	I	1500/34	--	11- 8-61	44.91	6135, 6447
-15ca1	Unknown	--	14.5	4'x 4'	U	--	5,894	8-11-67	13.24	--
40/52-2cc1	Ellison Ranching Co.	1952	105	4	D	16/4	--	8- 9-67	20.80	2016
-4d1	Snyder Bros.	--	22.7	4'x 4'	U	--	--	8- 9-67	17.81	--
-8ba1	Ellison Ranching Co.	--	8.5	6	D	--	--	8- 9-67	1.46	--
-12bb1	Wright	1942	109	6	D	--	--	8- 9-67	Plugged	--
-26ad1	C. Van Norman	1960	290	16	I	950/190	--	8-10-67	Pumping	6136
-26cd1	Bureau of Land Management	1955	120	6	S	--	--	8-10-67	Pumping	3056
-29da1	William Behn	1958	86	4	D	--	--	8-10-67	7.92	592
-32bb1	Don Williams	1948	7.5	4'x 4'	U	--	--	8-10-67	8.68	--
41/48-1ba1	Winters Ranch	--	--	22	U	--	--	8-12-67	7.82	--
41/52-2cc1	Melo Mori	1950	320	6	D	--	--	5-23-50	16.	1331
-27dd1	Ellison Ranching Co.	--	120	3	D	--	--	8-18-50	15.	--

Table 28.--Continued

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
41/52-28aa1	Ellison Ranching Co.	1950	126	6	U	--	5,720	8-18-50	7.89	48
-32dc1	Ellison Ranching Co.	1948	30	4	D	--	--	8- 9-67	1.48	49
41/58-10db1	Marble Ranches	--	--	3'x 5'	D	--	--	8- 8-67	6.93	--
42/48-7a1		--	340	--	S	--	5,345	1962	320	--
42/50-5bc1	IL Ranch	--	--	18	D	--	--	8-12-67	11.06	--
42/52-35bd1	Jack Creek Guest Ranch	1957	138	6	D	--	6,160	8- 9-67	76.24	--
42/62-1dc1	O. F. Boies	--	--	6	S	--	5,850	6-22-67	Pumping	--
-10ad1	O. F. Boies	1967	170	6	S	--	--	6-22-67	Pumping	--
-15da1	O. F. Boies	--	12	18	D,S	--	--	6-22-67	UTM	--
-15da2	O. F. Boies	--	8	36	U	--	--	6-22-67	Des.	--
42/63-12	Hwy. Construction	--	--	10	HC	--	--	6-23-67	30.11	--
43/50-16cc	IL Ranch	--	--	6	D	--	--	8-11-67	18.73	--
43/51-2cb1	Petan Ranches	--	--	2	S	--	5,500	8-13-67	UTM	--
43/54-11ca1	Tim Smith	1965	100	8	D	--	--	7-22-67	32.48	--
43/55-29aa1	Mrs. Annie Vega	1958	142	6	D	--	--	7-22-67	15.	--
43/57-4ba1	Fred Beitia	1959	72	6	U	--	--	8- 8-67	Flowing	4959
-10db1	PX Ranch	1963	108	6	D	--	--	10- -67	25.	7467
43/62-5dd1	A. H. Agee and O. F. Boies	1949	85	5.5	S	--	--	6-23-67	61.89	1080
43/63-2cc1	Eyer Boies	1952	87	6	D,S	--	--	6- -52	37.	--
-3bd1	A. H. Agee and O. F. Boies	1949	65	5.5	D,S	--	--	6-23-67	30.09	1081
-14ab1	Eyer Boies	1961	200	16	I	260/--	--	6-23-67	3.46	6109
-25bc1	CCC Camp (formerly)	--	327	8	U	--	--	6-22-67	17.43	--
44/44-36a1	Bureau of Land Management	1954	714	8	--	--	--	--	Dry	2550
44/48-2dd1	Desert Ranch	--	--	10	D	--	--	8-12-67	5.01	--
-11da1	Desert Ranch	--	--	10	S	--	--	8-12-67	6.14	--

Table 28.--Continued

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
44/49-2b1		--	578	--	S	--	5,334	--	543	--
44/50-3cb1	Petan Ranches	--	--	2	S	--	--	8-13-67	Pumping	--
-6ba1	YP Ranch	--	--	4'x 4'	U	--	--	8-13-67	10.11	--
44/51-17bc1	Petan Ranches	--	--	2	S	--	--	8-13-67	Pumping	--
-33cc	Petan Ranches	--	--	2	S	--	5,442	8-13-67	Pumping	--
44/55-27a1	P. Mendive Ranch	--	32	24	D	--	--	7-23-67	UTM	--
-27a2	R. Mendive	1962	80	6	D	--	--	7-23-67	UTM	--
44/57-35bb1	Bryan School House	--	--	2	U	--	--	8- 8-67	15.28	--
-35cc1	Bob Prunty	1912	23	2	U	--	--	8- 8-67	3.49	--
44/61-7a1	Gilmore Ranch	1967	300	8	S	--	--	6-24-67	190.01	--
-17aa1	Gilmore Ranch	1949	60	5.5	D	--	--	6-24-67	23.08	1079
44/63-14bb1	Oren Boies	1950	66	6	D	--	--	7-18-67	11.92	--
-14bb2	Oren Boies	--	72	6	D	--	--	7-18-67	22.51	--
-15db	Union Pacific Railroad	--	92	8	D,RR	85/--	--	7-18-67	Pumping	--
44/68-15ad	Gamble Ranches, Inc.	--	--	8	S	--	5,775	7-19-67	Pumping	--
45/48-18c1	Allied Land and Livestock	1955	510	4	S	--	--	9-20-55	475	3192
-25cc1	Desert Ranch	--	--	2	S	--	--	8-12-67	40.94	--
45/49-10db1	Petan Ranches	--	--	2	S	--	--	8-13-67	UTM	--
-12db1	Petan Ranches	--	--	2	S	--	5,335	8-13-67	UTM	--
45/50-19ab1	Petan Ranches	--	--	2	U	--	5,062	8-13-67	76.62	--
-32cc1	YP Ranch	--	--	2	S	--	--	8-13-67	Pumping	--
45/53-12db1	Wilkinson	--	--	4'x 4'	D	--	--	7-23-67	4.03	--
-24a1	Mountain City R.S.	--	--	6	D,FP	--	--	7-23-67	8.52	--
45/54-20cc1	Rizzi Ranch	1946	35	24	D	--	--	7-23-67	20.	--
-20cc2	Rizzi Ranch	1954	24	24	D	--	--	7-23-67	15.	--
45/61-24aa1	Golmore Ranch	1965	100	6	D	--	--	6-24-67	25.42	--
45/62-7ad1	R. D. Agee and L. Agee	1958	133	6	S	--	--	6-24-67	78.98	--

Table 28.--Continued

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
45/64-7da1	Bureau of Land Management	1940	410	8	S	10/0	5,550	6-23-67	262.14	--
-16b1	L. A. Armstrong	--	20	30	D	--	--	6-23-67	18.08	--
-16b2	L. A. Armstrong	--	--	4'x 4'	U	--	--	6-23-67	14.14	--
-16b3	L. A. Armstrong	--	25	36	D	--	--	6-23-67	7.94	--
-20bd1	Unknown	--	--	4'x 4'	D	--	--	6-23-67	65.03	--
-20cc1	Ross Martin	--	90	6	D	--	--	6-23-67	12.09	--
-20cd1	Nevada Hwy. Dept.	--	65	6	D	--	--	6-23-67	UTM	--
-20d1	Union Pacific Railroad	--	14	6	U	--	--	6-23-67	Des.	--
45/68-18cc1	Bedke Ranch	--	--	2	S	--	--	6-25-67	207.63	--
46/47-30a1	Allied Land and Livestock Co.	1955	540	6"to 4"	S	--	5,300	12-23-55	507	3276
46/49-32a1	G. Kidd	1963	650	6	U	--	--	10- -63	590	7642
46/51-29ca1	Shoshone Piute Tribe	1967	102	6	D	--	--	7-23-67	54.64	--
46/52-2ca1	do.	--	--	4'x 4'	D	--	--	7-23-67	18.97	--
-3ab1	do.	1967	--	6	D	--	--	8-14-67	15.96	--
-3ba1	do.	--	40.5	6	D	--	--	7-23-67	11.94	--
-3cd1	do.	1967	--	6	D	--	--	8-14-67	24.30	--
46/53-36bb1	Robert O'Meara	--	7	4'x 4'	D	--	--	7-23-67	6.37	--
46/58-21bc1	U.S. Forest Service	1964	50	6	PS	--	--	8- 8-67	5.32	--
46/64-4ca1	Bureau of Land Management	1940	341	6	S	--	--	6-26-67	273.29	389
-13cd1	Salmon River Cattlemen's Association	1949	55	5.5	U	--	--	9-24-49	40.	1083
-28cd1	do.	--	150	6	S	--	--	6-24-67	UTM	--
46/65-5cb1	Bureau of Land Management	1954	156	6	S	--	--	11-15-54	107.	2797
-16bd1	do.	1954	208	6	S	--	--	12- 1-54	162.	2798
-18cb1	do.	1954	180	6	S	--	--	11-25-54	128.	2799

Table 28.--Continued

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
46/69-2cd1	Trout Creek Ranch	1954	246	8	D	--	--	7-19-67	Flowing	2813
-15ab1	do.	1949	247	12	I	--	--	7-19-67	Flowing	1139
-28ba1	do.	--	--	8	S	--	--	7-19-67	Pumping	--
-32dc1	do.	--	--	6	S	--	--	7-19-67	UTM	--
47/51-1dd1	Shoshone Piute Tribe	--	--	6	D	--	--	7-23-67	UTM	--
-11ca1	State line well	--	--	4	U	--	--	8-14-67	50.91	--
-12db1	Shoshone Piute Tribe	--	--	6	D	--	--	7-23-67	9.52	--
-12dd1	do.	1967	--	8	D	--	--	7-23-67	10.89	--
47/52-8cc1	do.	--	--	4'x 4'	D	--	--	7-23-67	UTM	--
-8db1	do.	1967	--	--	D	--	--	8-14-67	6.82	--
-9ca1	do.	1967	--	6	D	--	--	8-14-67	7.01	--
-9dd1	do.	--	--	--	D	--	--	7-23-67	UTM	--
-15aa1	do.	--	--	6	S	--	--	7-23-67	15.17	--
-15ac1	do.	--	--	4'x 4'	U	--	--	8-14-67	9.31	--
-15db1	do.	--	75	6	D	--	--	7-23-67	26.24	--
-17ac1	do.	--	47.5	6	D	--	--	7-23-67	25.27	--
-17ac2	do.	--	--	6	D	--	--	8-14-67	19.58	--
-18aa1	do.	1967	--	6	D	--	--	8-14-67	16.12	--
-21ba1	do.	--	--	8	D	--	--	7-23-67	16.08	--
-21bd1	do.	--	--	8	D	--	--	7-23-67	11.97	--
-21dd1	do.	--	--	6	D	--	--	7-23-67	8.36	--
-21dd2	do.	--	--	4'x 4'	U	--	--	7-23-67	7.90	--
-23bb1	do.	--	--	6	D	--	--	7-23-67	24.66	--
-23bc1	do.	--	56	7	D	--	--	7-23-67	10.90	--
-23cc1	do.	--	45	8	D	--	--	7-23-67	5.46	--
-26ac1	do.	--	--	6	D	--	--	7-23-67	6.52	--
-26cc1	do.	--	--	6	D	--	--	8-14-67	5.12	--
-26cc2	do.	--	--	6	D	--	--	8-14-67	4.80	--
-26da1	do.	--	100	8	PS	--	--	8-14-67	Pumping	--
-27ca1	do.	--	45.6	--	D	--	--	7-23-67	UTM	--

Table 28.--Continued

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
47/52-27db1	Shoshone Piute Tribe	--	--	6	D	--	--	7-23-67	4.21	--
-33ad1	do.	--	--	6	D	--	--	8-14-67	1.78	--
-33dd1	do.	--	--	--	U	--	--	7-23-67	Plugged	--
-34bd1	do.	--	--	6	D	--	--	8-14-67	3.48	--
-34ca1	do.	--	--	6	D	--	--	8-14-67	10.82	--
-34cd1	do.	--	60.2	--	D	--	--	7-23-67	18.04	--
-35ac1	do.	--	58.5	6	D	--	--	7-23-67	Pumping	--
-35bb1	do.	--	--	6	D	--	--	7-23-67	7.02	--
-35bc1	do.	1967	--	6	D	--	--	8-14-67	UTM	--
-35bd1	do.	--	--	6	D	--	--	8-14-67	7.57	--
-35dc1	do.	--	33.5	6	D	--	--	7-23-67	15.75	--
47/64-1ca1	Diamond Jim's	1954	225	8	PS	--	--	6-27-67	Pumping	4995
-1cb1	Jackpot Shopping Center	1960	408	8	U	--	5,200	6-27-67	169.24	5203
-1cb2	Diamond Jim's	1960	260	6	U	--	--	6-27-67	UTM	5372
-1cc1	Cactus Pete's	1956	227	8	D	--	--	6-27-67	119.37	3475
-1cc2	Diamond Jim's	1958	260	6 5/8	D	--	--	6-27-67	UTM	4092
-1cc3	Cactus Pete's	--	--	8	PS	--	--	6-27-67	Pumping	--
-1cc4	Jackpot (Fire Protection)	1964	435	12	FP	150/35	--	8- 9-64	153.	--
-2ba1	W.D. Ranching Co.	1967	530	8	S	--	--	6-26-67	UTM	--
-12ab1	Elko County School District	1962	142	8	D	--	--	7-18-67	94.54	6476
-12ab2	Jack Steel	1960	179	6	D	--	--	4- 1-60	136.	5201
-12bb1	Cactus Pete's	1958	--	8	PS	--	5,234	9-30-58	103.31	--
-12bb2	do.	--	--	8	U	--	--	6-27-67	115.05	--
-12bb3	Horseshoe Club	--	225	8	PS	--	--	6-27-67	161.97	--
-12bb4	Barbara Higgins	1960	225	6	U	--	--	7-19-67	UTM	5202
-12bc1	Sage Trailer Court	--	--	--	PS	--	--	7-19-67	UTM	--

Table 28.--Continued

Well number	Owner or lessee	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) drawdown (feet)	Approximate altitude (feet)	Water-level measurement Date	Water-level measurement Depth	State log number
47/64-12bd1	Barton's Trailer Court	--	180	8	PS	--	--	7-19-67	Pumping	--
-13da1	W.D. Ranching Co.	1966	125	6	S	--	--	6-26-67	22.09	--
-23d1	Erickson	--	7	25	D	--	--	6-29-50	2.97	--
47/65-18bc1	W.D. Ranching Co.	1966	445	16	I	--	--	6-26-67	Pumping	9016
-18cb1	do.	1967	126	8	D	--	--	6-26-67	25.49	--
-18db1	do.	1967	618	20-10 3/4	I	1,200/--	--	1-24-68	Flowing	9900
-30cb1	Union Pacific Railroad	--	112	8	D,RR	--	--	6-26-67	61.52	--
-30cc1	Salmon River Cattlemen's Association	1964	150	6	S?	--	--	6-24-67	7.07	--
-33bd1	do.	1954	210	6	S	--	--	4-4-61	149.70	2800
-34d1	Bureau of Land Management	1954	450	10	U	--	--	6-26-67	(a)	--
(Idaho)										
16S/2-26cb1	Shoshone Piute Tribe	--	--	6	D	--	--	7-24-67	5.11	--

a. Dry hole at 443 feet.

Table 29.--Selected well logs

Material	Thickness (feet)	Depth (feet)
39/51-11bc1 (Driller's terminology and log)		
Surface	5	5
Sandy clay	10	15
Yellow clay	10	25
Water gravel	10	35
Yellow clay	10	45
Monzonite	15	60
Yellow clay	20	80
Monzonite	5	85
Brown hard clay (heaving)	25	110
Red sticky clay (heaving)	55	165
Gray clay	15	180
Monzonite	15	195
Rock	3	198
Sticky brown clay (heaving)	12	210
Monzonite	30	240
Rock	4	244
Yellow clay	6	250
Brown clay (heaving)	40	290
Yellow clay (soft)	35	325
Sandy brown clay	5	330
Sticky brown clay	20	350
Monzonite (brown)	10	360
Mineral ore	35	395
Blue shale	55	450
Gray rock	19	469
Yellow clay	8	477
Blue basalt	2	479
Monzonite	3	482
Conglomerate	38	520
Blue shale	55	575
Brown sandy clay and gravel	90	665
Gray shale	15	680
Rock and gravel	4	684
Gray clay	16	700
Volcanic ash	5	705
Brown monzonite	70	775
Gray clay and gravel	20	795
Brown clay	10	805
Gray clay	25	830
Volcanic gray tuff	10	840
Green shale	20	860
39/52-3cd1		
Boulders, gravel, and yellow clay, mixed	50	50
Clay, yellow	12	62
Gravel	11	73
Clay, yellow	7	80
Gravel and clay, mixed	59	139
Gravel	13	152
Sand and clay, mixed	4	156
Sand and gravel	16	172
39/52-4ad1		
Topsoil	6	6
Boulders, small, and gravel	6	12
Clay, brown	5	17
Gravel, clay, and rocks	73	90
Clay, brown, tough	20	110
Clay, brown, soft	24	134
Clay, hard, and gravel	10	144
Clay, brown, soft	134	278
Gravel, coarse, tight	4	282
Clay, brown	58	340
Clay, brown, sandy	90	430
Clay, brown, hard, and gravel	10	440
Gravel, free	1	441
Clay, brown, tough	4	445
	TD	450
40/52-26ad1		
Boulders	18	18
Clay and rocks	109	127
Gravel, loose, water	12	139
Clay and gravel	6	145
Gravel and sand	9	154
Clay, brown, tough	20	174
Gravel and sand, water	30	204
Clay and rocks	74	278
Gravel, tight	12	290

Table 29.--Continued

Material	Thickness (feet)	Depth (feet)
41/52-2cc1		
Clay	8	8
Boulders	4	12
Clay, yellow	13	25
Clay, red	5	30
Clay, yellow	37	67
Gravel and clay, mixed	29	96
Gravel	4	100
Gravel and clay, mixed	43	143
Shale, light blue, soft	47	190
Shale, sandy	10	200
Shale, blue, soft	95	295
Gravel	10	305
Shale, sandy	15	320
43/57-10db1		
Sand, black, with gravel	12	12
Clay, light brown, water	21	33
Clay, gray	18	51
Clay, broken, some water	15	66
Clay, light gray, sandy, and gravel, little water	15	81
Clay, dark brown, mixed with fine sand	14	95
Sand, blue, mixed with white quartz, water	13	108
43/63-14ab1		
Silt and soil	12	12
Gravel and sand, water	18	30
Clay, brown	13	43
Gravel	3	46
Clay, brown	11	57
Gravel	6	63
Clay, brown	9	72
Gravel	6	78
Clay, brown	4	82
Gravel	4	86
Clay, brown	11	97
Gravel	9	106
Clay	18	124
Sandstone, coarse	9	133
Clay, brown, and gravel in thin streaks	67	200

Material	Thickness (feet)	Depth (feet)
44/44-35a1		
Clay	15	15
Rock, red	35	50
Rock, red, hard	19	69
Rock, red	26	95
Rock, gray	30	125
Rock, brown, getting red	5	130
Rock, red	22	152
Rock, brown, hard	21	173
Rock, red with streaks of brown, hard ribs throughout	27	200
Rock, brown	12	212
Rock, gray	43	255
Rock, red	5	260
Rock, brown	20	280
Rock, gray	20	300
Rock, brown	15	315
Rock, gray	5	320
Rock, brown	15	335
Clay, yellow, hard, and gravel	80	415
Rock, brown, clay, and gravel	5	420
Clay, brown, gravel, and sand	25	445
Sand, coarse, hard, and gravel	25	470
Sand, white, and gravel	20	490
Sand, brown, coarse, and gravel	30	520
Clay, yellow, hard, and gravel	20	540
Rock, red, hard	10	550
Rock, red, extra hard	10	560
Rock, red, hard	25	585
Rock, red	15	600
Rock, gray, hard	65	665
No report	40	705
Rock, gray, hard	9	714

Table 29.--Continued

Material	Thickness (feet)	Depth (feet)
45/48-18cl		
Clay, yellow, hard	10	10
Lava rock, hard	52	60
Lava, red, soft	10	72
Lava, brown, hard	74	146
Lava, red, hard	27	173
Lava, brown, hard	42	215
Lava, gray, medium hard	57	272
Lava, red, soft	33	305
Lava, brown, medium hard	85	390
Clay, yellow	52	442
Lava, gray, hard	18	460
Lava, brown, medium hard	15	475
Lava, gray, soft	23	498
Lava, red, soft	7	505
Lava, gray, soft	5	510
46/47-30al		
Clay and rocks	3	3
Lava rock, brown, hard	94	97
Lava, red, medium	23	120
Lava, brown, hard	152	272
Lava, red, soft	3	275
Lava, brown, soft	52	327
Lava, red, loose, caves	51	378
Lava, brown, hard	12	390
Lava, brown, medium	25	415
Lava, gray, medium	125	540

Material	Thickness (feet)	Depth (feet)
46/49-32al		
Topsoil, boulders	1½	1½
Lava, red, broken	15½	17
Rock, brown, broken	43	60
Rock crevices, brown, hard	30	90
Lava, red, crevice 106'	15	105
Lava, red, porous, falling	43	148
Lava, brown	2	150
Lava, brown, broken	16	166
Lava, red, decomposed, soft	9	175
Clay, reddish brown, rocky	38	213
Clay, yellow, rock	12	225
Gravel, sandy, and clay, washed	15	240
Clay, yellow, some sand	25	265
Clay, brown, sandy	35	300
Gravel and clay	15	315
Clay, sandy	30	345
Gravel and clay	15	360
Clay, light brown, sandy	57	417
Gravel, sand, and clay	5	422
Sand and clay	24	446
Lava rock, hard	8	454
Clay, brown	51	505
Clay, brown, sandy	60	565
Clay, light brown, little clay	27	592
Sand, very fine, water seeps	18	610
Sandstone, harder	12	622
Sandstone	10	632
Sand, red, and clay	11	643
Sand, brown, hard clay	7	650

Table 29.--Continued

Material	Thickness (feet)	Depth (feet)
46/64-4ca1		
Sand soil, tan, soft	1	1
Sandstone, white, hard	19	20
Rock, black, hard	2	22
Gravel, black, soft	21	43
Rock, black, hard	17	60
Clay sand, tan, soft	45	105
Gravel, black, soft	20	125
Sand clay, tan, soft	4	129
Gravel, black, medium	51	180
Sand gravel, tan, medium	25	205
Clay, red, medium	27	232
Lava rock, red, hard	51	283
Sand clay, red, soft	25	308
Sand bar, yellow, hard; water	2	310
Clay, light tan, soft; water	16	326
Talc, light tan, soft, water	3	329
Sand, light brown, soft; water	1	330
Limerock, gray, hard; water	2	332
Talc, white, soft, water	2	334
Sand, black, soft, water	7	341
46/69-2cd1		
Topsoil	6	6
Clay and sand	3	9
Gravel	7	16
Clay, blue	10	26
Clay, brown, hard	15	41
Clay, blue	84	125
Gravel, cemented	74	199
Clay and gravel	38	237
Clay, brown, hard	5	242
Clay, brown, some gravel	4	246
Limerock, broken		---
46/69-15ab1		
Soil, black, sandy	11	11
Clay, blue, and gravel	17	28
Clay, tan, and gravel	2	30
Clay, reddish brown, and fine gravel	6	36
Lime, gray, sandy	9	45
Lime, gray, sandy, broken	16	61
Lime, light gray, sandy	30	91
Lime, brownish gray, broken	13	104
Lime, brownish gray, solid	3	107
Lime, brownish gray, broken, with light gray clay seams	37	144
Lime, brownish gray, solid	7	151
Lime, brownish gray, solid with trace of quartz	10	161
Lime, brownish gray, broken with clay seams	39	200
Sand, gray; water flowing 27 gpm	1	201
Sand, gray, and gravel	5	206
Lime, gray, broken, water flowing 450 gpm	14	220
Lime, gray, broken, caving, water flowing 1,356 gpm	27	247
47/64-1cb1		
Soil and rock	20	20
Sand	8	28
Sand and clay	147	175
Rock, broken	40	215
Sand and clay	163	378
Rock, hard	30	408
47/64-12ab1		
Soil	4	4
Sandstone, light	71	75
Clay, red, and sand	10	85
Rock, red	33	118
Clay and rock	12	130
Rock, red	12	142

Table 29.--Continued

Material	Thickness (feet)	Depth (feet)
47/65-13bc1		
Soil	3	3
Gravel	13	16
Sandstone	146	162
Clay, red	5	167
Rock, red	17	184
Clay, red, and gravel	3	187
Rock, red	136	323
Rock, red, hard	40	363
Rock, black	2	365
Clay, brown, and rock	3	368
Clay, red, and coarse sand	44	412
Rock, brown	7	419
Clay, sand, and gravel	9	428
Rock, red, broken	17	445
47/65-18db1		
Topsoil	5	5
Gravel and rhyolite, boulders	42	47
Rhyolite, red	44	91
Rhyolite, red, loose	17	108
Rhyolite, gray	8	116
Sand, gray	4	120
Clay, gray, sandy	18	138
Clay, brown, sandy	7	145
Sand, gray, cemented	3	148
Clay, brown	5	153
Rhyolite, brown	28	181
Rhyolite, red	44	225
Rhyolite, red, and gray clay	77	302
Clay, tan, and rock	13	315
Clay, red	73	388
Sandstone, hard	17	405
Clay and sandstone in alternate layers	70	475
Sandstone, gray	10	485
Clay, brown	30	515
Clay, brown, sandy	17	532
Clay, red	36	568
Clay, blue-gray	26	594
Shale, blue-green	5	599
Clay, blue-gray	11	610
Clay, brown, hard layers	8	618

REFERENCES CITED

Bushnell, Kent, 1967, Geology of the Rowland quadrangle, Elko County, Nevada: Nevada Bur. Mines Bull. 67.

Coash, J. R., 1967, Geology of the Mt. Velma quadrangle, Elko County, Nevada: Nevada Bur. Mines Bull. 68.

Coats, R. R., Marvin, R. F., and Stern, T. W., 1965, Reconnaissance of mineral ages of plutons in Elko County, Nevada: U.S. Geol. Survey Prof. Paper 525-D, p. D11-D15.

Coats, R. R., 1964, Geology of the Jarbidge quadrangle, Nevada-Idaho: U.S. Geol. Survey Bull. 1141-M, p. M1-M24.

Decker, R. W., 1962, Geology of the Bull Run quadrangle, Elko County, Nevada: Nevada Bur. Mines Bull. 60.

Eakin, T. E., 1962, Ground-water appraisal of Independence Valley, Elko County, Nevada: Nevada Dept. Conserv. and Nat. Resources, Ground-Water Resources - Reconn. Ser. Rept. 8, 31 p.

Eaton, F. M., 1950, Significance of carbonates in irrigation waters: Soil Sci., v. 69, p. 123-133.

Granger, A. E., and others, 1957, Geology and mineral resources of Elko County, Nevada: Nevada Bur. Mines Bull. 54.

Hardman, George, and Mason, H. G., 1949, Irrigated lands of Nevada: Nevada Univ. Agr. Expt. Sta. Bull., no. 183, 57 p.

Houston, C. E., and Naphan, E. A., 1952, Consumptive use of water in the irrigable areas of the Columbia River Basin in Nevada: U.S. Dept. Agriculture, Soil Conservation Service Pub., 35 p.

Kohler, M. A., Nordenson, T. J., and Baker, D. R., 1959, Evaporation maps for the United States: U.S. Weather Bur. Tech. Pub. 37.

Malde, H. E., and Powers, H. A., 1962, Upper Cenozoic stratigraphy of Western Snake River plain, Idaho: Geol. Soc. America Bull., v. 73, no. 10, p. 1197-1220.

Mapel, W. J., and Hail, W. J., Jr., 1959, Tertiary geology of the Goose Creek district, Cassia County, Idaho, Box Elder County, Utah, and Elko County, Nevada: U.S. Geol. Survey Bull. 1055-H, p. 217-254.

Moore, D. O., 1968, Estimating mean runoff in semiarid areas: Internat. Assoc. Sci. Hydrology Bull. XIII[e] Annee no. 1, p. 29-39; also released as Nevada Dept. Conserv. and Nat. Resources, Water Resources Bull. 36.

Mundorff, M. J., Crosthwaite, E. G., and Kilburn, Chabot, 1964, Ground water for irrigation in the Snake River Basin in Idaho: U.S. Geol. Survey Water-Supply Paper 1654, 224 p.

Piper, A. M., 1923, Geology and water resources of the Goose Creek basin, Cassia County, Idaho: Idaho Bur. Mines and Geol. Bull. 6, 78 p.

_____ 1924, Geology and water resources of the Bruneau River basin, Owyhee County, Idaho: Idaho, Bur. Mines and Geology, Pamphlet no. 11, 56 p.

Scofield, C. S., 1936, The salinity of irrigation water: Smithsonian Inst. Ann. Rept., 1935, p. 275-287.

Sharp, R. P., 1939, The Miocene Humboldt Formation in northeastern Nevada: Jour. Geology, v. 47, no. 2, p. 133-160.

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, 268 p.

Thomas, C. A., Broom, H. C., and Cummans, J. E., 1963, Magnitude and frequency of floods in the United States, Part 13, Snake River Basin: U.S. Geol. Survey Water-Supply Paper 1688.

Thornthwaite, C. W., 1948, An approach toward a rational classification of climate: Geog. Rev. v. 38, p. 55-94.

U.S. Public Health Service, 1962, Public Health Service drinking water standards, 1962: Public Health Service Pub. no. 956, 61 p.

U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkaline soils: U.S. Dept. Agriculture, Agriculture Handb., 60, 160 p.

Willden, Ronald, 1964, Geology and mineral resources of Humboldt County, Nevada: Nevada Bur. Mines Bull. 59.

LIST OF PREVIOUSLY PUBLISHED REPORTS IN THIS SERIES

Report No.	Valley	
1	Newark (out of print)	
2	Pine (out of print)	
3	Long (out of print)	
4	Pine Forest (out of print)	
5	Imlay area (out of print)	
6	Diamond (out of print)	
7	Desert	
8	Independence	
9	Gabbs	
10	Sarcobatus and Oasis	
11	Hualapai Flat	
12	Ralston and Stonecabin	
13	Cave	
14	Amargosa	
15	Long	Surprise
	Massacre Lake	Coleman
	Mosquito	Guano
	Boulder	
16	Dry Lake and Delamar	
17	Duck Lake	
18	Garden and Coal	
19	Middle Reese and Antelope	
20	Black Rock Desert	
	Granite Basin	
	High Rock Lake	
	Summit Lake	
21	Pahranagat and Pahroc	
22	Pueblo	Continental Lake
	Virgin	Gridley Lake
23	Dixie	Stingaree
	Fairview	Pleasant
	Eastgate	Jersey
	Cowkick	
24	Lake	
25	Coyote Spring	
	Kane Spring	
	Muddy River Springs	
26	Edwards Creek	
27	Lower Meadow	Patterson
	Spring (near Panaca)	
	Panaca	Eagle
	Clover	Dry
28	Smith Creek and Ione	
29	Grass (near Winnemucca)	
30	Monitor, Antelope, Kobeh	
31	Upper Reese	
32	Lovelock	
33	Spring (near Ely) (out of print)	
34	Snake	
	Hamlin	
	Antelope	
	Pleasant	
	Ferguson Desert (out of print)	
35	Huntington	
	Dixie Flat	
	Whitesage Flat (out of print)	
36	Eldorado - Piute Valley (Nevada and California)	
37	Grass and Carico Lake (Lander and Eureka Counties)	
38	Hot Creek	
	Little Smoky	
	Little Fish Lake	
39	Eagle (Ormsby County)	
40	Walker Lake	
	Rawhide Flats	
	Whiskey Flat	
41	Washoe Valley	
42	Steptoe Valley	
43	Honey Lake	Warm Springs
	Newcomb Lake	Cold Spring
	Dry	Lemmon
	Red Rock	Spanish Springs
	Bedell Flat	Sun
	Antelope	
44	Smoke Creek Desert	
	San Emidio Desert	
	Pilgrim Flat	
	Painters Flat	
	Skedaddle Creek	
	Dry (near Sand Pass)	
	Sano	

LIST OF PREVIOUSLY PUBLISHED REPORTS IN THIS SERIES -- continued.

Report No.	Valley	
45	Clayton Valley	Stonewall Flat
	Alkali Spring	Oriental Wash
	Lida	Grapevine Canyon
46	Mesquite Valley	Hidden Valley
	Ivanpah Valley	Jean Lake Valley
47	Thousand Springs Valley	

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

QUATERNARY

Younger alluvium

Unconsolidated gravel, sand, silt, and clay; mainly the wet-land segments of the flood plains; commonly less than 100 feet thick; moderate to high permeability; yield to wells may be several hundred gallons a minute, depending on the saturated thickness; and includes principal areas of ground-water discharge and phreatophytes

Older alluvium

Unconsolidated to partly consolidated gravel, sand, silt, and clay; principally alluvial fan and related deposits; may be several hundred feet thick in Independence Valley; two wells in Independence Valley reportedly yield as much as 1,000 gallons a minute from this unit

TERTIARY AND QUATERNARY

Sedimentary rocks

Sandstone, shale, siltstone, conglomerate, marl, and chert with substantial amounts of tuffaceous sandstone, tuff, and agglomerate; includes possibly 5,000 feet of deposits in Bull Run Basin referred to Humboldt Formation by Decker (1962) and Humboldt Formation of Sharp (1939), in Salmon Falls Creek Valley south of Contact. Large volume of ground-water stored in zone of saturation, but yields to wells generally small due to low permeability

Volcanic rocks

Principally Miocene and Pliocene silicic volcanic rocks; commonly tuff, welded tuff and lava flows but includes Eocene Dead Horse Tuff, Miocene (?)Jarbidge Rhyolite, Pliocene Cougar Point Welded Tuff, and associated sedimentary rocks. Large volume of ground-water stored in zone of saturation of these rocks; yields to wells generally small due to low permeability; but moderate to high yields may be obtained locally where secondary fractures are open. These rocks supply many small mountain springs and some larger ones such as Shoshone Creek about 5 miles East of U.S. Highway 93

MESOZOIC AND TERTIARY

Instrusive rocks

Largely granitic rocks of varied composition. May range in age from Jurassic to Tertiary. Relatively impermeable but surficial jointing and weathering provides limited secondary permeability. Locally supplies small mountain springs

PALEOZOIC AND MESOZOIC

Carbonate and associated rocks

Limestone, sandstone, quartzite, shale and volcanic rocks; consolidated, indurated, cemented, locally metamorphosed; complexly faulted and folded, commonly close-spaced fractures; thickness, 25,000 feet or more. Secondary permeability in upper few hundred feet permits infiltration of precipitation which, in turn, sustains many small mountain springs and streams through the dry season. Favorable fracture or solution systems in carbonate rocks locally may transmit significant quantities of water, such as apparently sustains the large springs southwest of San Jacinto and north of Sugar Loaf Peak along Goose Creek. Wells 46/69-2cd1 and 46/69-15ab1 in Goose Creek Valley probably tap carbonate rocks

Contact
Approximately located

Drainage divide

Gaging station, continuous

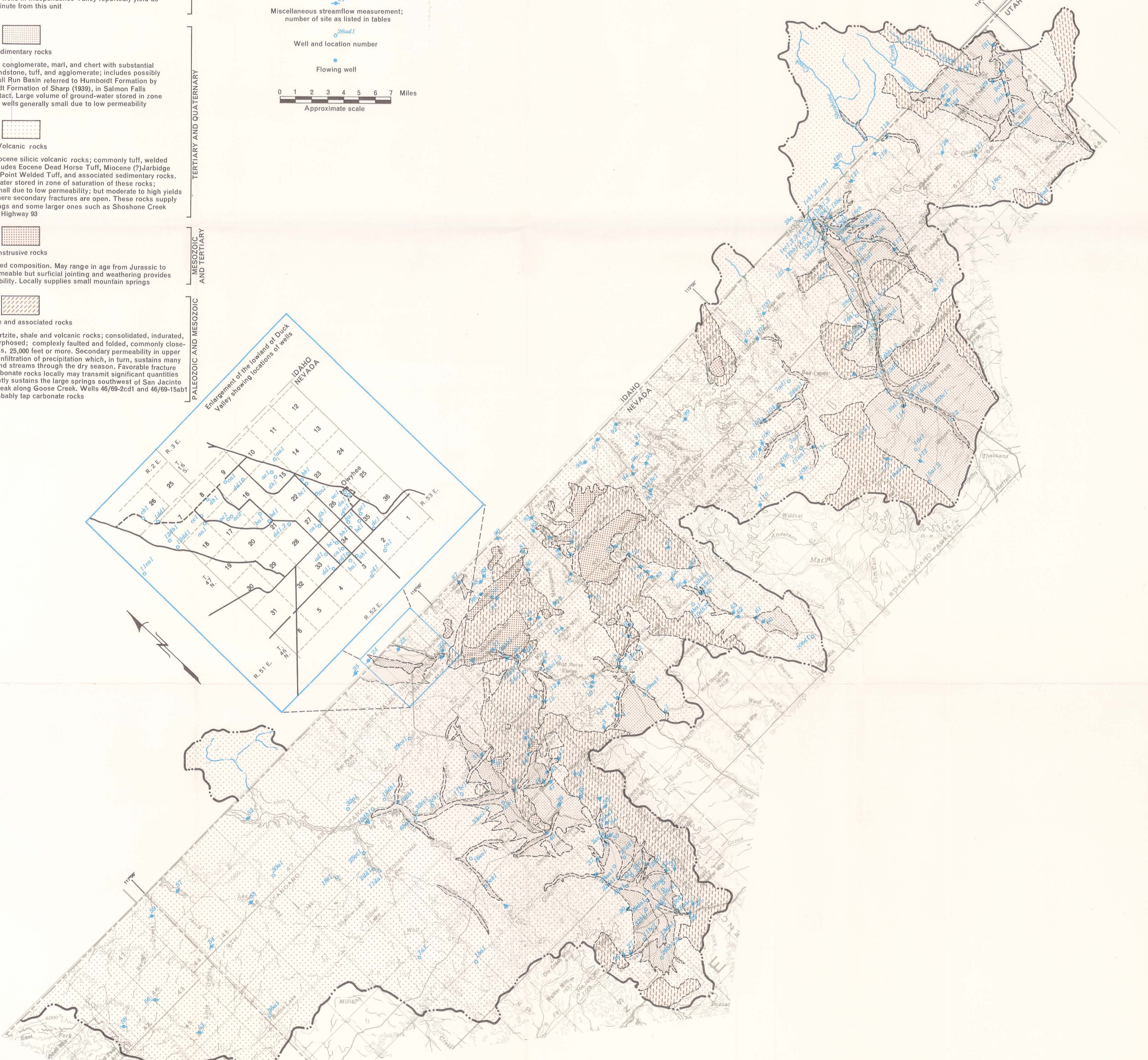
Gaging station, short term

57
Miscellaneous streamflow measurement; number of site as listed in tables

26ad1
Well and location number

Flowing well

0 1 2 3 4 5 6 7 Miles
Approximate scale



Base from U.S. Geological Survey Topographic Map of Nevada

Geology adapted from Bushnell (1967), Coash (1964), Granger and others (1957), Malde and Power (1966), Mapel and Hail (1959), Piper (1923), and Wilden (1964). Hydrology by T. E. Eakin (1967).

PLATE 1.—GENERALIZED HYDROGEOLOGIC MAP OF THE SNAKE RIVER BASIN IN NEVADA