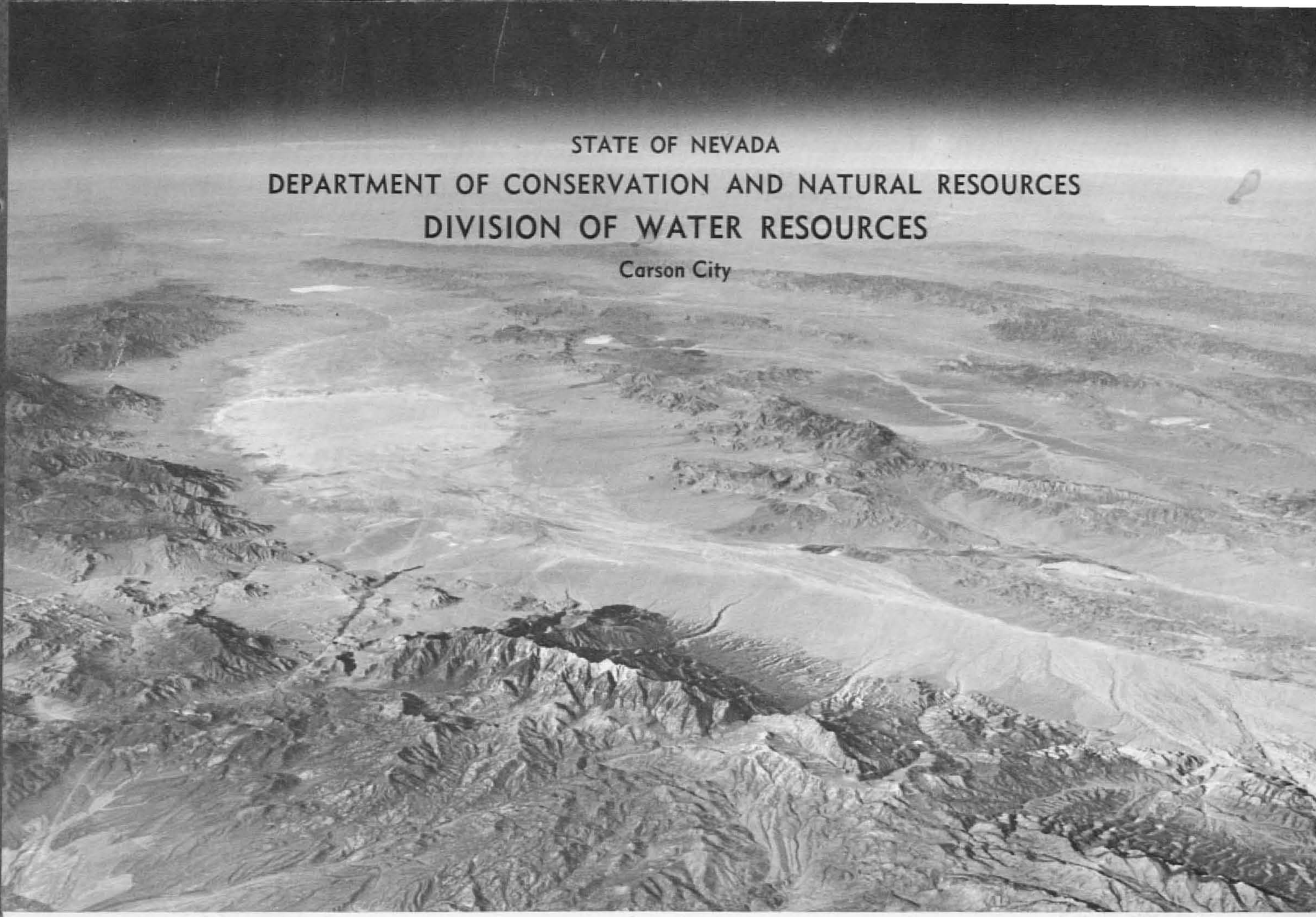
STATE OF NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF WATER RESOURCES

Carson City



WATER RESOURCES - RECONNAISSANCE SERIES

REPORT 60

WATER–RESOURCES APPRAISAL OF RAILROAD AND PENOYER VALLEYS, EAST–CENTRAL NEVADA

By

A. S. Van Denburgh

and

F. Eugene Rush

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

1974

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FOREWORD

The program of reconnaissance water-resources studies was authorized by the 1960 Legislature to be carried on by the Department of Conservation and Natural Resources, Division of Water Resources, in cooperation with the U.S. Geological Survey.

This report is the 60th report prepared by the staff of the Nevada District of the U.S. Geological Survey. These 60 reports describe the hydrology of 219 valleys.

The reconnaissance surveys make available pertinent information of great and immediate value to many State and Federal agencies, the State cooperating agency, and the public. As development takes place in any area, demands for more detailed information will arise, and studies to supply such information will be undertaken. In the meantime, these reconnaissance-type studies are timely and adequately meet the immediate needs for information on the water resources of the areas covered by the reports.

Roland D. Westergard
State Engineer

Division of Water Resources

1974

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By A. S. Van Denburgh and F. Eugene Rush

SUMMARY

The 3,452-square-mile study area lies in the Great Basin, south of Eureka. Altitudes range from 11,513 feet atop Currant Mountain to 4,706 and 4,738 feet at the lowest points in Railroad and Penoyer Valleys, respectively. Precipitation averages about 5 inches per year at lowest altitudes, and more than 20 inches in the highest areas. Railroad Valley contains three large spring groups: Big Warm Spring at Duckwater, with a flow of about 13 cfs (cubic feet per second), the second largest in Nevada; Blue Eagle Spring south of Currant, flowing about 4 cfs; and the several springs at Lockes, totalling about 3 cfs. The valley also boasts the only oil production in Nevada, at the small Eagle Springs Field south of Currant.

Table 1 summarizes the quantitative hydrologic character of each valley. Annual water use in the valleys as of 1972 included the following: Irrigation, which is restricted to Railroad Valley, consumed about 14,000 acre-feet of ground water (mostly springflow) and about 1,500 acre-feet of water from Currant Creek; flooding for waterfowl habitats in Railroad Valley consumed about 1,300 acre-feet; domestic use totaled 10-15 acre-feet, all but a fraction of which was in Railroad Valley; livestock used on the order of 20-30 acre-feet in Railroad Valley and less than 10 acre-feet in Penoyer Valley; and the oil field produced about 20 acre-feet of brine as a byproduct of the oil.

The chemical character of water in the report area is variable. Except beneath and immediately adjacent to the three playas, where salinity is excessive, most ground water is relatively dilute (specific conductance characteristically ranges from 300 to 800 micromhos). The dissolved solids are dominated by bicarbonate and either calcium or sodium. In some parts of northern Railroad Valley, the water is fresher at depth than in the uppermost waterbearing zones. Stream waters resemble the ground waters, or diluter versions thereof. For domestic use, the excessive hardness of many waters and the unsuitable fluoride content of some are the only known quality problems. Almost all water in the two valleys is suitable for irrigation.

Table 1.--Hydrologic summary

[Estimates in acre-feet per year, except as indicated]

	Railroad Valley			
	Northern part	Southern part	Entire valley	Penoyer Valley
Area (square miles)	2,149	603	2,752	700
Surface-water runoff from mountains	25,000	1,000	26,000	1,000
Potential ground-water recharge from precipitation	46,000	5,500	52,000	4,300
Evapotranspiration	80,000	200	80,000	3,800
Reconnaissance value for ground-water inflow and outflow	75,000	5,500	75,000	4,000
Preliminary estimate of perennial yield	75,000	2,800	75,000	4,000
Preliminary estimate of transitional storage reserve (total acre-feet)	3,000,000	400,000+	3,400,000+	770,000

At the Eagle Springs Oil Field, the hot brine from consolidated rocks at great depth may present a long-term, localized contamination problem.

INTRODUCTION

Purpose and Scope of the Study

Ground-water development in Nevada has increased substantially in recent years. Part of this increase is due to the effort to bring new land into cultivation. The growing interest in ground-water development has created a substantial demand for information on ground-water resources throughout the State. Recognizing this need, the State Legislature enacted special legislation (Chapter 181, Statutes of 1960) authorizing a series of reconnaissance studies of the ground-water resources of Nevada. As provided in the legislation, these studies are being made by the U.S. Geological Survey in cooperation with the Nevada Department of Conservation and Natural Resources, Division of Water Resources. This is the 60th report prepared as part of the reconnaissance studies (fig. 1 and p. 56).

In the early studies, little information on the surface-water resources was presented. Later, this reconnaissance series was broadened to include a preliminary quantitative evaluation of surface water in the valleys studied.

The objectives of the reconnaissance studies are to (1) describe the hydrologic environment, including the source, occurrence, movement, and chemical quality of the water, (2) estimate the average annual recharge to, discharge from, and yield of the ground-water reservoirs, (3) evaluate quantitatively the surface-water resources of the valleys, (4) provide preliminary estimates of present water development, and (5) evaluate the potential for future development. Much of the descriptive information and data that provide a base for the present study has already been given by Eakin and others (1951), and is referenced rather than repeated in this report. Thus, the specific intents of this restudy are to update, enlarge upon, and where necessary, refine the excellent work of Eakin and others, using hydrologic data and techniques not available to them.

Most of the field work for this report was done during November 1970, October 1971, and March 1972, with A. S. Van Denburgh responsible for the study of Railroad Valley, and F. E. Rush for work in Penoyer Valley. The "Surface water" section was prepared by T. L. Katzer and Lynn Harmsen, on the basis of field work done by them and by R. D. Lamke.

Location and General Features of the Area

The study area lies in the Great Basin in east-central Nevada, south of Eureka (lat 37°30'-39°15' N., long 115°15'-116°25'W.; see fig. 1). The area includes northern and southern Railroad Valley, which cover 2,149 and 603 square miles, respectively, and Penoyer Valley (also known as Sand Spring Valley), which encompasses 700 square miles.

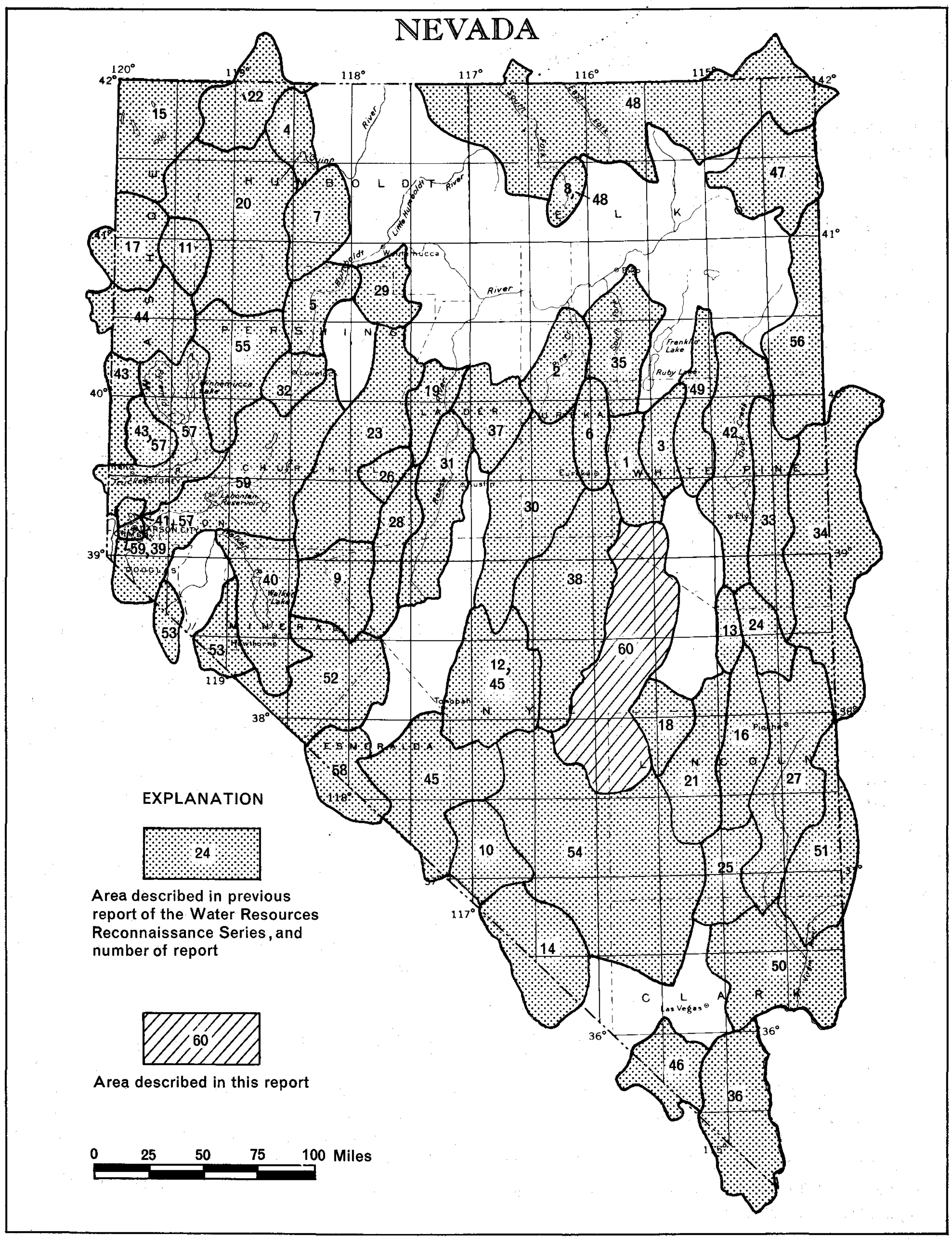


Figure 1.—Areas described in previous reports of this series, and the area described in this report

The Duckwater Indian Reservation and Currant, both in Railroad Valley, are the only settlements in the study area, and they have a combined population of almost a hundred; elsewhere, people are few and far between. Agriculture--mostly cattle-raising and related activities--employs most of the study area's population.

Railroad Valley boasts the only oil production in Nevada, at the small Eagle Springs Field south of Currant. The petroleum was discovered in 1954 by Shell Oil Co., amazingly enough during the drilling of their first exploratory well in Nevada (Murray and Bortz, 1967, p. 2133). Oil production through 1971 totaled 2,525,672 barrels (monthly report, Nevada Oil and Gas Conservation Commission, Reno, Nev., Feb. 4, 1972).

Despite the implication, no train has ever crossed Railroad Valley. The name may have been derived from the route of the proposed Ely-Goldfield Railroad--a venture that never reached construction stage (Hance, 1914, p. 457).

Previous Studies Related to Hydrology

Although Everett Carpenter briefly discussed the hydrology of Railroad Valley in 1915 (p. 75-79), the first detailed hydrologic report was that of Eakin and others (1951), which also includes a brief description of Penoyer Valley. Their report was based on a rather comprehensive reconnaissance, and contains valuable descriptive, quantitative, and tabular material, much of which is not repeated in the present report. More recently, Snyder (1963) has dealt briefly with the water resources of the north part of Railroad Valley, and Summerfield and Peterson (1971, p. 10) have presented a short hydrologic discussion of the entire valley. Regional reports that contain discussions of Railroad Valley include those of Mifflin (1968) and Fiero (1968). Similarly, Eakin and others (1963) deal briefly with Penoyer Valley.

Basic-data reports that contain information on Railroad and Penoyer Valleys include the following:

Report	Data listed
U.S. Geol. Survey (1960, 1966-72, 1970a)	Discharge records for streams and (in the report for 1968) springs
Robinson and others (1967)	Hydrologic and chemical data for wells and springs north of T.1S.
Thordarson and Robinson (1971)	Hydrologic data for wells and springs south of T.9N.

Valleys surrounding the study area have been investigated hydrologically as follows:

Valley	Direction from present study area	Report
Garden and Coal	East	Eakin (1963, 1966), Snyder (1963)
Gold Flat	Southwest	Rush (1970), Winograd and others (1971), Eakin and others (1963)
Hot Creek	West	Rush and Everett (1966), Dinwiddie and Schroder (1971), Eakin and others (1951)
Jakes	Northeast	Eakin (1966), Snyder (1963)
Kawich	South	Rush (1970), Winograd and others (1971), Eakin and others (1951, 1963)
Little Smoky	West	Rush and Everett (1966), Dinwiddie and Schroder (1971), Snyder (1963)
Newark	North	Eakin (1960), Snyder (1963)
Tikapoo (Desert) and Groom Lake (Emigrant)	South	Rush (1970), Winograd and others (1971), Eakin and others (1963)
White River	East	Eakin (1966), Maxey and Eakin (1949), Snyder (1963)

Acknowledgments

Several residents of the area have provided valuable hydrologic information. We are particularly grateful to the Tom Russells and the Joe Fallinis for their assistance and hospitality. In addition, W. A. Beetem, D. D. Gonzalez, and R. E. Smith of the U.S. Geological Survey, along with H. R. Finlayson and R. H. LeDosquet of the U.S. Bureau of Land Management and their staffs, have provided important data on wells and springs. J. H. Schilling of the Nevada Bureau of Mines and Geology has made available detailed information on oil exploration wells. The help of all these people is very much appreciated, as is the field assistance and camaraderie of Bruce R. Scott of the Nevada Division of Water Resources.

GENERAL HYDROLOGIC ENVIRONMENT

Physiographic Setting

Railroad Valley is one of the longest topographically closed drainage basins in Nevada, extending more than 110 miles in a generally north-south direction, with a width of 15 to 25 miles. The surrounding mountain masses are dominated by the lofty White Pine, Grant, and Quinn Canyon Ranges east of the valley floor, as shown on plate 1. Altitudes range from 11,513 and 11,298 feet atop Currant Mountain and Troy Peak to 4,706 feet at the lowest point on the huge northern playa and about 4,845 feet on the much smaller southern playa. Many small, ephemeral streams drain rugged mountainous areas along the east side of the valley, but streamflow rarely reaches the central valley floor. Large springs discharge at three places, and other less productive springs are common in the northern half of the valley, particularly along the east side. The three largest spring systems, Duckwater (13/56-32bac and 12/56-5 and 6; see section titled "Numbering system for hydrologic sites"), Blue Eagle (8/57-11ddb), and Lockes (8/55-14 and 15), provide a combined flow of about 22 cfs (cubic feet per second).

Penoyer Valley, by comparison to Railroad Valley, is small. The surrounding mountains include the Quinn Canyon Range on the north, Worthington (Shadow) Mountains and Timpahute Range on the east, Groom Mountain on the south, and Belted Range on the west. Relief within the drainage basin ranges from an altitude of 9,229 feet in the Quinn Canyon Range at the north to about 4,738 feet on the centrally located playa.

Railroad Valley contained two large lakes during the late Pleistocene Epoch, more than 7,000 years ago. By far the largest water body covered as much as several hundred square miles of valley floor southwest of Currant. According to Snyder and others (1964), the lake attained a maximum depth of 315 feet, inundating 525 square miles, but these data may be in error. The highest shoreline detected on aerial photographs during the present study is at an altitude of 4,870-4,875 feet, on the basis of more recent topographic control than was available to Snyder and his coworkers. The existence of a lake more than a few tens of feet higher than 4,870 feet, even briefly, is doubtful. Thus, because the lowest point on the valley floor is at about 4,706 feet altitude, the maximum depth relative to the present-day floor may have been only 170-200 feet, rather than 315 feet, and the comparable lake area would have been on the order of 430 square miles. The huge lake (25-30 million acre-feet, or 7½-9 cubic miles) reflects climatic conditions wetter and probably somewhat cooler than those of today. The lake was fed by streamflow not only from Railroad Valley itself but from neighboring Hot Creek Valley, and perhaps in turn from Little Fish Lake Valley farther to the west. Thus, the total tributary drainage area may have been as much as 4,200 square miles.

Southern Railroad Valley also contained a lake, but a much smaller one. According to Snyder and others (1964), the southern lake covered about 50 square miles, and at high levels overflowed to the larger northern lake. A combination of photographic and topographic evidence suggests that overflow probably did occur, at an altitude of 4,940-4,950 feet, indicating a maximum depth of about 100 feet. The area covered at this depth would have been approximately 55 square miles. A small lake with an area of only a few square miles may have occupied the lowest part of Penoyer Valley.

The older topographic sheets used of necessity during this study include several inaccuracies that are rather critical from the standpoint of ground-water interpretations in the two valleys:

1. The Lund Sheet (scale, 1:250,000) gives an altitude of 4,625 feet for the playa floor in northern Railroad Valley, which is about 70 feet lower than the actual altitude. In addition, the 4,800-foot contour south of the playa is mislocated by as much as 4 miles, on the basis of more recent, detailed mapping (pl. 1 shows the correct approximate location). The 4,800- and 4,900-foot contours north of the playa also are incorrectly located, but to a lesser degree.

2. The Reveille Peak quadrangle (scale, 1:62,500) gives valley-floor altitudes in southern Railroad Valley that are on the order of 10-15 feet too high, on the basis of closed altimeter traverses and more recent bench marks.

3. The Caliente Sheet (scale, 1:250,000) shows altitudes that are as much as 400 feet too low in eastern Penoyer Valley, on the basis of more recent, detailed mapping.

4. The White Blotch Springs quadrangle (scale, 1:62,500) gives altitudes near the central part of the Penoyer Valley that are on the order of 20 feet too low, on the basis of closed altimeter traverses and more recent bench marks.

Geologic Units and Structural Features

Rocks of the report area are divided into four major lithologic units: noncarbonate rocks, carbonate rocks, and older and younger alluvium. This division is based largely on hydrologic properties. The areal extent of the units at land surface is shown on plate 1. The geology is based principally on the following county geologic maps: Northern Nye County, by Kleinhampl and Ziony (1967); southern Nye County, by Cornwall (1967); Lincoln County, by Tschanz and Pampeyan (1961); and White Pine County, by Hose and Blake (1970).

Noncarbonate rocks, Precambrian to Quaternary in age, are dominated by volcanic tuff, with lesser amounts of other volcanic rocks (rhyolitic to basaltic flows), as well as quartzite, shale, and granitic intrusives. The carbonate rocks are mostly Cambrian to Permian in age and are dominated by limestone. Included with the carbonate rocks are the tufa spring deposits of Quaternary age at Duckwater, Lockes, and 5 miles south of Lockes. Together, the noncarbonate and carbonate rocks form the mountain masses and underlie the alluvium. In Nevada, the carbonate rocks transmit, on a local and regional scale, large amounts of water. In Railroad Valley, the three major spring systems (Blue Eagle, Duckwater, and Lockes) probably are associated with carbonate rocks. The noncarbonate rocks are generally much less permeable than the carbonates.

Except for major springs, most of the economically available ground water in Railroad and Penoyer Valleys is stored in alluvial deposits, or valley fill. The older alluvium, of Tertiary and Quaternary age, is the principal body of alluvium that underlies the valley floors and the surrounding alluvial slopes. It consists of generally semiconsolidated to unconsolidated lenses of gravel, sand, silt, and clay. The material is derived from the adjacent mountains and transported to the valley mostly by flowing water. The sand and gravel lenses commonly yield water readily to wells.

Beneath the lowest parts of each valley floor, the older alluvium is covered by as much as a few hundred feet of younger alluvium. The younger alluvium, of Quaternary age, consist of lenses of gravel, sand, silt, and clay which are unconsolidated, and generally thinner than the lenses of older alluvium. The sands and gravels are generally better sorted and therefore more permeable, and have a higher capacity to yield water to wells. The playa and some associated lake deposits are mostly composed of silt and clay, and therefore are poor sources of water.

The total thickness of alluvium in northern Railroad Valley is great in places; logs of oil-exploration wells indicate valley-fill deposits at depths as great as 9,200 feet (see inset figure, pl. 1). The general character of valley-fill deposits penetrated by wells in the study area is indicated by representative well logs in table 13.

Faults that control the occurrence and movement of ground water are shown on plate 1.

GROUND-WATER RESERVOIRS

Extent and Boundaries

In the study area, large quantities of ground water occur in both the valley fill and in the underlying consolidated rocks. Younger and older alluvium (pl. 1) form the valley-fill reservoirs, which are the principal sources of well water in the study area. The valley fill covers about 1,170 square miles (54 percent of the total area) in northern Railroad Valley, about 400 square miles (66 percent) in southern Railroad Valley, and about 430 square miles (61 percent) in Penoyer Valley. In the central part of Railroad Valley, the reservoir is thick, as indicated by data from oil-exploration wells (see inset figure on pl. 1). In other parts of the valley and in adjacent Penoyer Valley, the alluvium has been explored to depths of only 200-400 feet. In these areas, shallow bedrock has not been encountered, except near the land-surface contact between the bedrock and alluvium. (For example, well 11/56-2adc, about a mile southeast of the land-surface contact, encountered volcanic rock at only 28-foot depth.)

External hydraulic boundaries of the valley-fill reservoirs are formed by the consolidated rocks (pl. 1), which underlie and surround the reservoirs. These boundaries are leaky to varying degrees. The principal internal hydraulic boundaries are lithologic changes and faults that may cut the valley fill. The extent to which these lithologic and structural barriers impede ground-water flow is uncertain in most places.

The consolidated-rock reservoir consists of volcanic and carbonate rocks (see pl. 1 and table 13). Carbonates dominate the rocks exposed on the east sides of Railroad Valley, north of T.3N., and Penoyer Valley, and are commonplace on the west side of Railroad Valley north of T.7N. Elsewhere, exposures of carbonate rocks are rare. However, the proportion probably increases at depth, both surrounding and beneath the valley fill. The distribution of volcanic rocks is opposite to that of the carbonates: the volcanics are scattered in the northwest part of the study area, rare to the northeast, and commonplace in the south, with the abundance decreasing at depth.

Occurrence and Movement of Ground Water

Availability of ground water in the two valleys is indicated in a general way by well drillers' reports of the depth at which water was first encountered during drilling, by reported well yields, and by the static and pumping water levels in the completed wells (table 12). Data on spring locations and flow rates (table 15) also provide information on ground-water availability.

Ground water, like surface water, moves from areas of higher head (water-level altitude) to areas of lower head. Unlike surface water, however, it moves very slowly, commonly at rates ranging from a fraction of a foot to several hundred feet per year, depending on the permeability of the deposits and the hydraulic gradient.

Most ground water generated within Railroad and Penoyer Valleys moves from recharge areas in the mountains or on the adjacent alluvial slopes to the lowlands, where the water is discharged at the land surface by evapotranspiration or, in southern Railroad Valley, at depth by subsurface leakage to adjacent areas to the north (northern Railroad Valley) and south (Kawich Valley).

The consolidated rocks that underlie and surround Railroad and Penoyer Valleys transmit water through fractures associated with faulting. Carbonate rocks are potentially the most permeable, at least locally, because the rock-forming carbonate minerals are slightly soluble, permitting development of a more open and interconnected fracture system. In eastern and central Nevada, the carbonate rocks comprise several regional ground-water reservoirs that transmit large quantities of water from valley to valley (for example, see Eakin, 1966, and Winograd and others, 1971). On the basis of a hydrologic budget imbalance (p. 28), the estimated inflow from Little Smoky and Hot Creek Valleys (Rush and Everett, 1966, table 10), and the presence of prolific springs, Railroad Valley is the destination of intervalley ground-water flows by way of consolidated rocks. Penoyer Valley is not known to have any interbasin leakage, and therefore probably is a hydrologically closed system.

INFLOW TO THE VALLEY-FILL RESERVOIRS

Precipitation

Precipitation in the study area is characterized by snow and rain from generally eastward-moving storm systems during the winter, and by thundershowers associated with northward air movements during the late spring and summer. Table 2 and the data of Hardman and Mason (1949, p. 10) show that annual precipitation in the study area averages about 5 inches at lower altitudes and more than 20 in the higher areas.

Surface Water

By T. L. Katzer and Lynn Harmsen

Available Records

Little Currant Creek near Currant, Nev. (location, 11/59-5ba; altitude, 6,700 feet) is the only continuous-recording streamflow gaging station within the study area. Quantities of flow during the period are listed in table 3, and figure 2 shows the monthly distribution of flow.

In addition to Little Currant Creek, there are a few other perennial streams in the study area. Four of these streams were measured or estimated for this study:

Name	Location	Date	Discharge 1/ (cfs)
Big Creek	4/55-23db	11-8-70	0.3 m
Willow Creek	4/56-18c	11-7-70	.4
Hooper Creek	5/56-35aa	11-7-70	.1 m
Troy Canyon Creek	6/57-29d	11-7-70	.1 m

1. Measured flows are indicated by "m". Other value was estimated.

Table 2.--Average annual precipitation at weather stations in and adjacent to the study area
[From published records of the U.S. Weather Service]

Station[1]	Altitude (feet)	Period of full-year record used	Average annual precipitation for period of record used (inches)	Estimated long-term average precipitation (inches) [2]
1. Charnac Basin[3]	8,500	Sept. 1955-Aug. 1970	12.7	13
2. Lower Robinson[3]	7,550	Aug. 1960-July 1968	13.9	13
3. Connors Pass[3]	7,330	Aug. 1962-July 1970	14.6	14
4. Snowball Ranch	7,160	1967-70	10.1	8
5. Currant Creek Summit[3]	6,820	Aug. 1958-July 1968	10.7	11
6. Eureka	6,540	1965-70	14.1	12
7. Ely Weather Service Office	6,250	1939-70	8.8	9
8. Adaven	6,250	1939-70	12.4	12
9. Currant Highway Station	6,240	1964-69	9.9	9
10. Duckwater	5,400	1967-70	7.8	6
11. Blue Jay Highway Station	5,300	1967-68	7.0	6
12. Diablo	5,000	1960-65, 1967-70	5.5	5
13. Penoyer Valley	4,800	1969-70	6.7	5

1. Stations are listed in descending order of altitude. See small inset map on pl. 1 for locations.
2. Based on 32-year period of record, 1939-70, for Ely and Adaven stations.
3. Precipitation-storage gage.

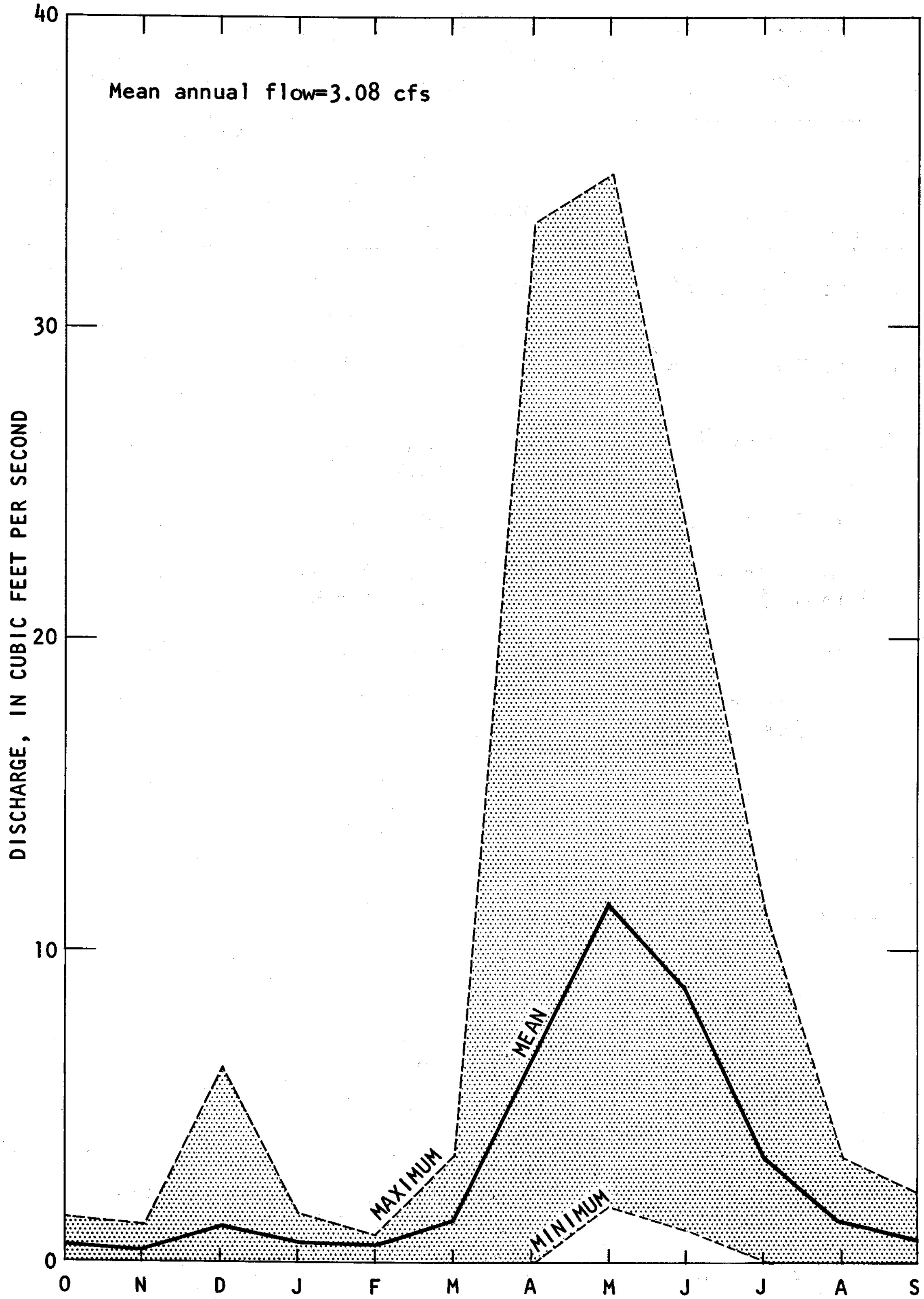
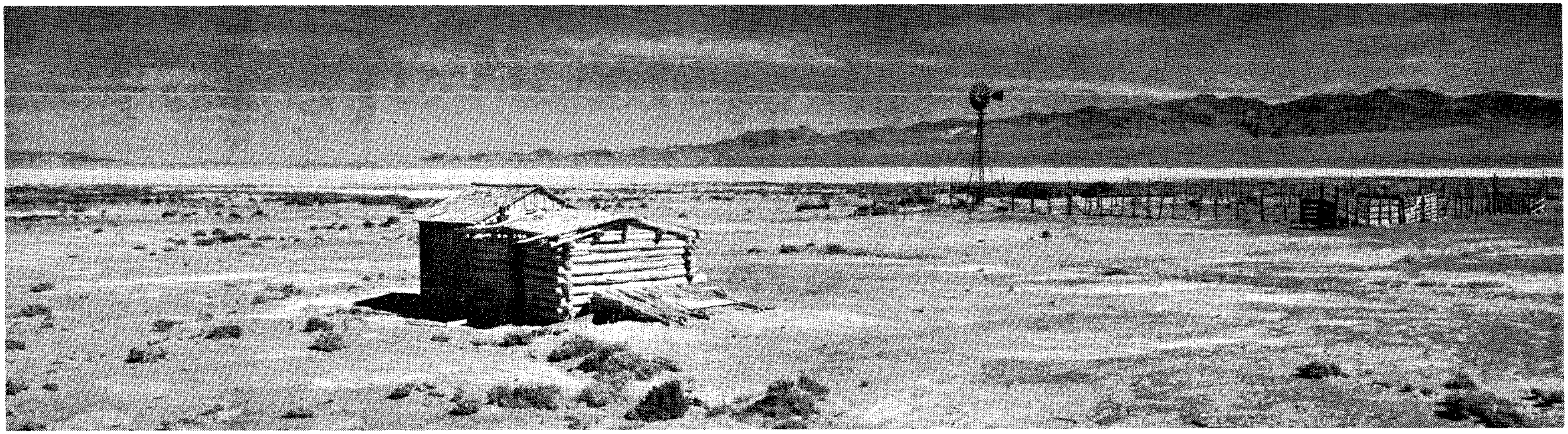


Figure 2.--Monthly flow distribution for Little Currant Creek, water years 1965-72 (location 11/59-5ba).

A



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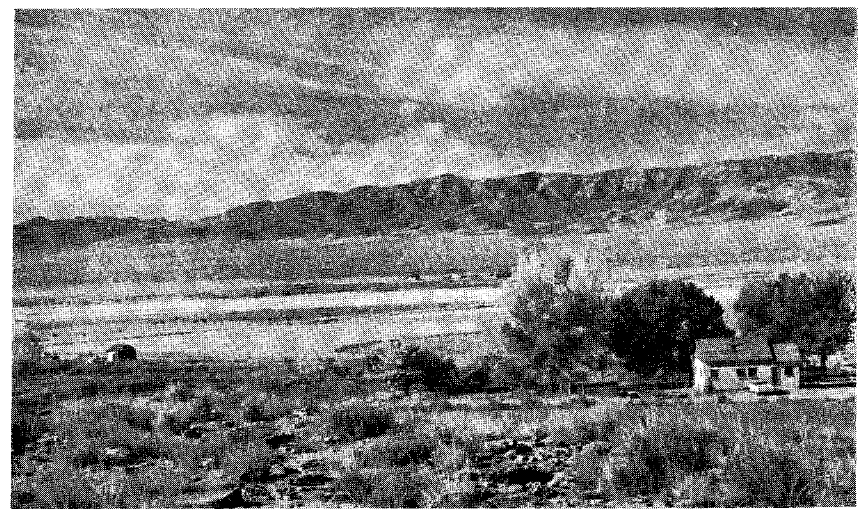


Photographs 3A-C.--*A*. Panorama at Fred's Well (1/53-7adc) in southern Railroad Valley. Playa in background. View northeastward. The 136-ft stock well yields very soft water containing excessive fluoride. *B*. Abandoned oil-exploration well 8/57-22cdc, 4½ miles south of Eagle Springs Oil Field. Blue Eagle Mtn. in background. View eastward. Well is Shell Oil Co. Eagle Springs Unit no. 4; total depth 7,885 ft; bedrock encountered at 6,632 ft. *C*. Farms at Duckwater Indian Reservation. Pancake Range in background. View southwestward from 12/56-6aca. Irrigation water is provided by Big and Little Warm Springs (about 13 and 0.4 cfs, respectively).

Table 3.--Instantaneous maximum and minimum discharges, and total annual flow of Little Currant Creek, 1965-72 (location 11/59-5ba)

Water year	Acre-feet	Maximum (cfs)	Minimum (cfs)
1965	1,100	<10	0.00
1966	880	6.6	.00
1967	5,600	366	.00
1968	680	4.1	.00
1969	5,900	50	.00
1970	930	5.1	.18
1971	2,100	35	.02
1972	740	3.7	.00
Average	2,200	-	-

Five partial-record stations are operated by the Geological Survey for the determination of maximum discharge. Table 4 summarizes these data. Also included are Geological Survey data from two ungaged sites in northern Railroad Valley. The Bureau of Land Management monitors a 100-square-mile drainage in northern Railroad Valley for peak flows and precipitation. Table 4 summarizes the peak-flow data.

Streamflow Characteristics

The runoff pattern for Little Currant Creek is typical in that low flow (no flow most years) is reached in late summer or early winter and increases little until the spring runoff starts in March or April with peaking flows in May and June. This is also the pattern of snowmelt runoff that can be expected from the remaining area that contributes to surface-water runoff in perennial streams.

Peak flows resulting from rainstorms and thunderstorms dwarf snowmelt peak flows; however, the amount of water supplied in this manner generally is negligible when compared with the snowmelt peak which has a much longer time duration.

Runoff can be further defined geographically. Precipitation as snow is dominant in the White Pine, Grant, and Quinn Canyon Ranges on the east side of Railroad Valley with the remaining area receiving precipitation primarily from rainstorms and thunderstorms.

Table 4.--Maximum discharge at partial-record stations and other selected sites

Station	Location	Drainage area (sq mi)	Water year	Maximum discharge Date	Cubic feet per second
				Partial-record stations	
Penoyer Valley tributary	4S/56-21ad	1.48	1964	--	No flow
			1965	7-30-65	a 2
			1966	--	No flow
			1967	--	No flow
			1968	8- 6-68	130
			1969	6-19-69	45
			1970	7-21-70	35
			1971	--	No flow
Black Rock Summit tributary	8/54-34ca	5.0	1967	7- -67	a 200
			1968	--	No flow
			1969	6-15-69	a 150
			1970	--	No flow
			1971	--	a 10
Railroad Valley tributary	8/55-21bb	.37	1962	6- -62	a 5
			1963	9- -63	a 10
			1964	--	No flow
			1965	--	No flow
			1966	--	No flow
			1967	9-22-67	a 2
			1968	7-30-68	a 5
			1969	--	No flow
			1970	--	No flow
			1971	--	No flow
Currant Creek tributary	11/59-15ba	3.13	1962	--	No flow
			1963	6-10-63	b 100
			1964	--	No flow
			1965	8-12-65	a 1
			1966	9-19-66	a 0.2
			1967	6- -67	a 7
			1968	7-30-68	a 2
			1969	3-30-69	a 70
			1970	7- -70	a 10
			1971	5- -71	a 0.3
Currant Creek below Little Currant Creek	11/59-16ba	30.0	1964	6-17-64	8
			1965	5- -65	10
			1966	4-11-66	a 7
			1967	12- 6-66	400
			1968	7-30-68	5

Table 4.--Maximum discharge at partial-record stations and other selected sites--continued

Station	Location	Drainage area (sq mi)	Water year	Maximum discharge Date	Cubic feet per second
Current Creek below Little Currant Creek--continued			1969	4- 1-69	200
			1970	7- -70	60
			1971	5- -70	10
Duckwater Creek tributary[1]	14/56-19cc	100	1963	9-20-63	420
			1964	6-17-64	5
			1965	8- 1-65	2,500
			1966	8- 2-66	75
			1967	8- 2-67	660
			1968	7-24-68	530
			1969	7-24-69	540
			1970	7-22-70	3,300
			1971	--	No flow
Other sites					
Duckwater Creek tributary near Currant	11/57-22ca	b 4	1970	7-22-70	c 1,600
Bull Creek near Duckwater	13/56-1bd	117	1970	7-22-70	c 2,200

a. Estimated. Other discharges determined by indirect methods.
b. Approximate.
c. Rounded.
1. Duckwater study area, Nevada Watersheds Project, U.S. Bureau of Land Management (data from Bur. Land Management, Reno, Nev., 1972). Discharges determined by indirect methods.

Mountain Front Runoff

It is impractical to gage the total runoff from a mountain block, such as the Grant or White Pine Range; however, methods have been developed by Moore (1968) that allow an indirect determination. The drainages for Railroad and Penoyer Valleys are in a zone where no appreciable runoff is generated below an altitude of 7,000 feet; therefore, for each 1,000-foot altitude zone above 7,000 feet, runoff values have been assigned based on an altitude-runoff relationship. This runoff value is refined by measuring certain channel characteristics (perennial and ephemeral) at the 7,000-foot altitude and relating these characteristics to the mean annual flow. A sampling of these measurements is listed in table 5.

The total average annual runoff available at the bedrock-alluvium contact for Railroad Valley is about 26,000 acre-feet per year, and for Penoyer Valley is about 1,000 acre-feet per year. From table 6, which summarizes the runoff from the various parts of the study area, it can be seen that the White Pine, Grant, and Quinn Canyon Ranges in northern Railroad Valley supply almost all of the available runoff.

Average annual flows in major ephemeral stream channels at four places on the valley floor have been estimated using the channel-geometry method developed by Moore (1968):

Location	Average annual flow (acre-feet)
2S/52-17add (unnamed stream)	<100
5/55-18ba do.	<100
12/57-18ac (Bull Creek)	<200
13/56-19cad (unnamed stream)	<100

The data indicate that almost all mountain-front runoff is dissipated by percolation and evapotranspiration in upland parts of the valley fill.

Surface-Water Inflow

Surface water enters Railroad Valley from adjacent Hot Creek Valley by way of Twin Springs Slough (location, 4/52-19bc). Published and unpublished records of streamflow for water years 1968-71 suggest that the long-term average may be about 1,200 acre-feet per year.

Some water is transported from northern to southern Railroad Valley by ditch, for stock watering. The ditch is fed by Echo Canyon Reservoir (3/52-3b), which in turn receives inflow from Hot Creek Valley. The average ditch flow may be on the order of 500 acre-feet per year, of which only a small amount presumably percolates to recharge the ground-water reservoir.

Ground-Water Recharge from Precipitation

Recharge is provided by precipitation in the mountainous areas, with the water reaching the valley-fill reservoirs by seepage loss from streams on the alluvial slopes and by underflow from the consolidated rocks. Even in the mountains and on alluvial slopes, however, most of the precipitation is evaporated before infiltration, whereas some of the remainder adds to soil moisture, and a little reaches already saturated lowland areas. Thus, only a very small percentage actually recharges the ground-water reservoir. On valley floors in the study area, precipitation quantities are small, and infiltration to the ground-water reservoir is generally minimal.

Table 5.--Long-term mean annual flow at selected sites determined by channel-geometry methods
[All measurements made at about 7,000-foot altitude]

Name	Location	Mountain range	Valley	Long-term mean annual flow (acre-feet)
Big Creek	4/55-23d	Quinn Canyon	N. Railroad	1,000
Ox Spring Wash	4/57-5c	Grant	do.	800
Johnson Canyon	9/58-32d	do.	do.	170
Unnamed	12/55-9b	Pancake	do.	220
Broom Canyon	12/58-19b	White Pine	do.	140
Unnamed	13/54-8a	Pancake	do.	100
Blackrock Canyon	13/57-13cb	White Pine	do.	150
Unnamed	14/54-13b	Pancake	do.	200
Cathedral Canyon	15/57-13db	White Pine	do.	80
Unnamed	1S/50-11dd	Kawich	S. Railroad	100
Unnamed	1S/57-6c	Worthington	Penoyer	100

Table 6.--Estimated average annual runoff at the mountain front

Area	Area contributing runoff (acres)	Percentage of total area	Estimated runoff (acre-feet per year)	Percentage of total runoff
RAILROAD VALLEY, NORTHERN PART				
East side	216,000	74	23,000	88
West side	47,000	16	2,000	8
Total	263,000	90	25,000	96
RAILROAD VALLEY, SOUTHERN PART	28,000	10	1,000	4
RAILROAD VALLEY, TOTAL	291,000	100	26,000	100
PENOYER VALLEY	24,000	100	1,000	100

Recharge from precipitation is estimated in this report using the general method described by Eakin and others (1951, p. 79-81). The method assumes that for any given altitude zone, a particular increment of total precipitation is available for recharge of the ground-water reservoir, with that increment, or percentage, depending on the average amount of snow and rainfall within the zone. Table 7 lists the estimates of precipitation and recharge for the study area. The total quantity of recharge for Railroad Valley, about 50,000 acre-feet per year, is the same as that estimated by Eakin and others (1951, p. 151) using less accurate topographic and precipitation data but much the same precipitation-altitude relation. For Penoyer Valley, the estimate of 4,300 acre-feet per year is far less than the annual increment of 13,500 acre-feet computed by Eakin and others (1951, p. 156); however, they recognized that the calculated quantity was far too large. They concluded that some 3,000 acre-feet per year might be available for development, which agrees reasonably well with the estimated perennial yield derived in this report (table 10). A more recent estimate of recharge was made by Eakin and others (1963, p. 13). Their estimate, 3,600 acre-feet per year, is in close agreement with the value developed for the present report.

Estimated amounts of recharge in Railroad and Penoyer Valleys are far greater than quantities of mountain-front runoff: estimated recharge is about 50,000 and 4,300 acre-feet per year, respectively, whereas estimated runoff is only 26,000 and 1,000 acre-feet. The runoff: recharge ratios are about 0.5:1 and 0.2:1 for Railroad and Penoyer Valleys, compared with an estimated statewide average of 1.5:1 (Nevada Division of Water Resources, 1971, p. 12). This contrast and the presence of carbonate rocks throughout much of the recharge area in each valley suggest that a significant part of total recharge occurs in the carbonate rocks upstream from the mountain front. In fact, these conditions also suggest that the estimates of recharge may be low.

Subsurface inflow to Railroad Valley from adjoining areas is another source of ground-water recharge; it is discussed in the following section and on page 28.

Subsurface Inflow

Ground water apparently enters Railroad Valley through the consolidated rocks in at least two areas. Rush and Everett (1966, p. 25) proposed that inflow from the southern part of adjacent Little Smoky Valley feeds the group of springs at Lockes and three smaller springs to the south (pl. 1), for which the total flow is about 2,400 acre-feet per year. Water-level contours presented and discussed by Dinwiddie and Schroder (1971, p. 62-64) for deep ground water in southern Little Smoky Valley support an east-northeastward direction of movement toward the vicinity of the Lockes Springs. Rush and Everett (1966, p. 18) also suggest the possibility of ground-water movement from the northeastern

Table 7.--Estimated average annual precipitation and ground-water recharge

Altitude zone (feet)	Area (acres)	Estimated precipitation Range (inches)	Average (feet)	Average (acre-feet)	Estimated recharge Percentage of total precipitation	Estimated recharge (acre-feet per year)
RAILROAD VALLEY, NORTHERN PART						
9,000-11,513	22,000	>20	1.8	40,000	25	10,000
8,000- 9,000	58,800	15-20	1.5	88,000	15	13,000
7,000- 8,000	183,000	12-15	1.1	200,000	7	14,000
6,000- 7,000	368,000	8-12	.8	290,000	3	8,700
5,000- 6,000	421,000	5-8	.5	210,000	minor	--
4,706- 5,000	324,000	<5	.4	130,000		
Total (rounded)	1,380,000	--	.7	960,000	5	a/ 46,000
RAILROAD VALLEY, SOUTHERN PART						
8,000- 8,863	2,330	15-20	1.5	3,500	15	520
7,000- 8,000	26,100	12-15	1.1	29,000	7	2,000
6,000- 7,000	130,000	8-12	.8	100,000	3	3,000
5,000- 6,000	173,000	5-8	.5	86,000	minor	--
4,845- 5,000	49,300	<5	.4	20,000		
Total (rounded)	381,000	--	.6	240,000	2	b/ 5,500
RAILROAD VALLEY, SOUTHERN AND NORTHERN PARTS						
Total (rounded)	1,760,000	--	.7	1,200,000	4	52,000
PENOYER VALLEY						
9,000- 9,229	60	>20	1.8	110	25	30
8,000- 9,000	3,500	15-20	1.5	5,200	15	780
7,000- 8,000	20,200	12-15	1.1	22,000	7	1,500
6,000- 7,000	85,000	8-12	.8	68,000	3	2,000
4,738- 6,000	334,000	<8	.5	170,000	minor	--
Total (rounded)	443,000	--	.6	270,000	2	4,300

a. Approximately 80 percent of recharge is generated on east side of valley.

b. Approximately 60 percent of recharge is generated in the Reveille Valley area of southern Railroad Valley.

part of southern Little Smoky Valley toward Duckwater.

Ground water flows into Railroad Valley from neighboring Hot Creek Valley by way of alluvium underlying Twin Springs Slough (4/52-19). Eakin and others (1951, p. 151) and Rush and Everett (1966, p. 25-26) estimate the average annual subsurface inflow to be about 700 acre-feet.

Within Railroad Valley, possibly 4,000 acre-feet per year moves from the southern to the northern part through alluvium and, perhaps, carbonate rocks (p. 25). Thus, accounted for subsurface inflow to northern Railroad Valley totals an estimated 7,000 acre-feet per year (rounded).

OUTFLOW FROM THE VALLEY-FILL RESERVOIRS

Evapotranspiration

In areas of shallow ground water, discharge (outflow) occurs by evaporation from bare playa soil and by transpiration from plants called phreatophytes, whose roots tap the ground water. The principal phreatophytes in Railroad and Penoyer Valleys are greasewood, rabbitbrush, saltbush, saltgrass, and, where ground water is very shallow, meadowgrass, tules, willow, and other marsh-loving vegetation. The phreatophytes and areas of playa evaporation are shown on plate 1, and estimates of evapotranspiration are summarized in table 8. The rates used are based on work done in other areas by Lee (1912), White (1932), Young and Blaney (1942), Houston (1950), and Robinson (1965).

Evaporation from surface-water bodies (mostly small ponds) is minor in total compared with other water losses. The average evaporation rate may be 4-4½ feet, on the basis of data of Kohler and others (1959, pl. 2).

The total amount of evapotranspiration estimated for Railroad Valley, about 80,000 acre-feet per year, is greater than the "order of magnitude of 50,000 acre-feet" given by Eakin and others (1951, p. 151). The higher value is a result of somewhat more refined procedures for evaluating evapotranspiration, better maps, and more water-level data. In Penoyer Valley, the present estimate (3,800 acre-feet per year) is appreciably less than that of Eakin and others (1951, p. 156; 6,400 acre-feet), but is in close agreement with the present estimate of annual ground-water recharge.

Surface-Water Outflow

Surface water is exported by ditch from northern to southern Railroad Valley for stock-watering ponds (p. 18). The flow may be about 500 acre-feet per year.

Springs

Several of the springs in Railroad Valley are among the largest in Nevada. The most prolific group is at Duckwater, where Big and Little Warm Springs and several smaller outlets yield a total flow of about 15 cfs (11,000 acre-feet per year). A group of smaller but nonetheless important springs at Lockes yields about 3.3 cfs (2,400 acre-feet per year). Many springs and seeps line the eastern

Table 8.--Estimated average annual ground-water evapotranspiration[1]

Type of water loss	Area (acres)	Depth to water (feet)	Evapotranspiration Feet per year	Evapotranspiration Acre-feet per year
		NORTHERN RAILROAD VALLEY		
Playa (bare soil)	38,000	0-10	0.1	3,800
Greasewood, rabbitbrush, saltbush, moderately dense to scattered	68,000	10-50	0.2	14,000
Saltgrass, with or without above phreatophytes, moderately dense to scattered	110,000	1-10	0.4	44,000
Meadowgrass, tules, willow, and other wet-area phreatophytes (includes areas of meadowgrass irrigated mostly with springflow)	12,000	0-5	1.5	18,000
Free-water surface	400	--	4	1,600
Total (rounded)	227,000	--	--	80,000
		SOUTHERN RAILROAD VALLEY[2]		
Greasewood, moderately dense to scattered	1,500	30-50	0.1	200
		PENOYER VALLEY[2]		
Greasewood, moderately dense to scattered, with minor amounts of saltgrass	19,000	15-50	0.2	3,800

1. Discharging playa and most phreatophyte areas are shown on plate 1.
2. The playa in this area does not discharge appreciable amounts of ground water because the depth to water is greater than 15 feet.

margin of the floor of Railroad Valley from 12 to 30 miles south of Currant. By far the largest are Blue Eagle Springs (8/57-11ddb), which produce about 4.2 cfs (3,000 acre-feet per year).

In Penoyer Valley, Sand Spring (2S/55-26dda) flows about a quart per minute of 86°F (30°C) water from the east flank of a large tufa mound. Atop the mound is a small, but prominent, outcrop of quartzite that can be seen for a distance of more than 3 miles.

Data for the springs mentioned above, and for many less prolific ones that emerge from, or along the margins of, the valley fill, are listed by Eakin and others (1951, tables 4 and 6), the U.S. Geological Survey (1969, p. 161), and in tables 15 and 16 of this report. Many other small springs dot the mountainous areas surrounding Railroad and Penoyer Valleys. For example, such springs provide much of the flow of Currant Creek. These upland springs are not tabulated in this report because they are not related directly to the valley-fill reservoir.

Subsurface Outflow

Most of the recharge to the southern part of Railroad Valley is discharged by subsurface outflow through alluvium and probably carbonate rocks. Blankennagel and Weir (1973, p. B20) suggest that about 1,000 acre-feet per year moves southward from the southern part of Railroad Valley to Kawich Valley. Although the actual quantity may be appreciably more than 1,000 acre-feet per year, their estimate is nonetheless retained in this report in the absence of quantitative evidence to the contrary. Except for a few hundred acre-feet of evapotranspiration around the playa, all remaining recharge in southern Railroad Valley, about 4,000 acre-feet per year, may move northward to northern Railroad Valley. In the eastern part of southern Railroad Valley (pl. 1), water-level gradients in the alluvium are northward, which confirms the direction of at least part of the outflow. (The situation in the Reveille Valley area of southern Railroad Valley is uncertain, owing to a lack of data on water-level gradients.)

No water is thought to leave northern Railroad Valley or Penoyer Valley by subsurface leakage.

Water Use

Irrigation

Irrigation in the study area is restricted by northern Railroad Valley, with pasture grass and alfalfa the principal crops. Most of the water is obtained from springs: areas irrigated with springflow total about 5,000 acres, including approximately 3,000 acres in the Duckwater area and about 1,000 acres along the east side of the valley between Blue Eagle Springs and Crows Nest, 16 miles to the southwest (acreages are from Summerfield and Peterson, 1971, p. 10). In several areas on the east side of the valley, springflow is augmented by water from flowing wells. Water use in areas irrigated mostly by springflow may total approximately 12,000 acre-feet per year (assuming an annual consumption of 2 to 3 acre-feet per acre). This quantity represents two-thirds of the total discharge from irrigated and nonirrigated areas of meadowgrass and other wet-area phreatophytes associated with the springs (table 8; 18,000 acre-feet per year).

Only one area of appreciable size, the long, thin strip of land along Currant Creek, relies on streamflow for irrigation. There, about 600 acres are farmed (Summerfield and Peterson, 1971, p. 10), and the amount of water consumed may be on the order of 1,500 acre-feet per year.

Desert Land Entry permits cover almost 7,600 acres in northern Railroad Valley, including 1,600 acres near Green Spring Ranch (in and adjacent to 15/57-32), 2,694 acres near Currant, and 3,285 acres near Nyala (Summerfield and Peterson, 1971, p. 10). In Penoyer Valley, patented entries total about 7,200 acres (data from U.S. Bur. Land Management, Reno, 1972). Only a small fraction of the total Desert Land Entry area was being actively worked as of 1972: 600-700 acres near Nyala; less than 300 acres near Currant, and no lands in Penoyer Valley. In fact, some of the patented land in Penoyer Valley is being advertised for subdivision. Water consumption in the farmed Desert Land Entry areas may be on the order of 2,000-2,500 acre-feet per year, all of which comes from wells.

Several areas are irrigated using flowing wells to maintain suitable habitats for waterfowl. Wells owned by the U.S. Bureau of Sport Fisheries and Wildlife in or adjacent to 6/56-5, 8/55-24, 8/56-2, and 8/57-4 (table 12) flow at a combined rate that may total about 800 gpm (1,300 acre-feet per year), most of which is consumed by evaportranspiration.

Domestic and Stock

Domestic supplies, almost all obtained from springs and wells in Railroad Valley, may total 10-15 acre-feet per year; only a part of that quantity is consumed. Livestock, which also rely on wells and springs, may use 20-30 acre-feet in Railroad Valley and probably less than 10 acre-feet in Penoyer Valley during the part of each year that they graze in lowland areas.

Oil Field

The Eagle Springs Oil Field produces brine as an unavoidable byproduct of the oil. Although the water-to-oil ratio differs greatly from well to well, the field-wide average may be about 60 percent water (Tom Russell, North American Resources Corp., oral commun., 1972). Total oil production from 1954, when the field was developed, through 1971 was 2,525,672 barrels (p. 5). Annual production has been as high as 309,000 barrels (1966), but has averaged only 140,000 barrels per year; in 1971 the total was about 113,000 barrels (Schilling and Garside, 1968, table 1; and data releases of the Nevada Oil and Gas Conservation Commission, Reno, Nev.). Assuming the 60:40 ratio, brine production has averaged about 200,000 barrels (26 acre-feet) per year. In 1972, the amount may have been about 20 acre-feet. The brine is separated from the oil and piped into ponds, where most of it infiltrates the valley-fill alluvium (very little evaporates because of oil film on the pond surfaces).

GROUND-WATER BUDGETS

For long-term natural or near-natural conditions, ground-water inflow to and outflow from an area are about equal, assuming that climatic conditions remain reasonably constant. Thus, a ground-water budget can be used (1) to compare the estimates of natural inflow to and outflow from each valley, (2) to determine the magnitude of errors in the two estimates, provided that one or more elements are not calculated by difference, and (3) to select a value that best seems to represent both inflow and outflow, within the limits of reconnaissance accuracy. This value in turn is utilized in a following section of the report to estimate the perennial yield of each area.

Table 9 presents ground-water budgets for the study area, and shows the reconnaissance value selected to represent both inflow and outflow under natural or near-natural conditions. In Penoyer Valley, the quantities of inflow and outflow are about equal, suggesting an essentially closed hydrologic system. In contrast, the water thought to be lost from Railroad Valley by evapotranspiration (81,000 acre-feet per year) exceeds by 27,000 acre-feet per year the estimated replenishment by recharge from precipitation plus estimated subsurface inflow (54,000 acre-feet per year). For purposes of this reconnaissance, the higher value is given more weight because one or more of the following conditions may prevail: (1) estimated runoff is small compared to the estimated recharge (ratio 0.5:1), suggesting that the recharge may be greater than estimated (table 7) because of extensive areas of carbonate rocks in the mountains; (2) estimates of subsurface outflow from Hot Creek and Little Smoky Valley to Railroad Valley (about 3,000 acre-feet per year according to Rush and Everett, 1968, p. 25-26) could be considerably greater than estimated; and (3) outflow from Newark, Jakes, and White River Valleys to the north and east could occur through carbonate rocks in the mountain blocks, although water budgets for those areas seem to balance reasonably well (Eakin, 1960, 1966).

Nevertheless, the prolific Duckwater and Blue Eagle Spring systems (combined discharge about 19 cfs, or 14,000 acre-feet per year) suggest that ground-water inflow in addition to the 7,000 acre-feet per year accounted for already (table 9) may enter northern Railroad Valley from adjacent but as yet unidentified valleys. In addition, geochemical evidence suggests that Duckwater and Blue Eagle Springs are related to regional ground-water flow (Mifflin, 1968, p. 37 and app. table 5).

The preceding paragraphs suggest that the inflow to and outflow from northern Railroad Valley may more nearly approximate the estimated outflow of about 80,000 acre-feet per year than the estimated inflow of 54,000 acre-feet per year. Accordingly, the value selected for this reconnaissance to represent inflow and outflow is 75,000 acre-feet per year.

Table 9.--Preliminary ground-water budgets for natural or near-natural conditions
[All estimates are in acre-feet per year]

Budget elements	Railroad Valley Northern part	Railroad Valley Southern part	Railroad Valley Entire valley	Penoyer Valley
INFLOW				
Ground-water recharge from precipitation (table 7)....	46,000	5,500	51,000	4,300
Subsurface inflow (p. 20)....	a 7,000	--	3,000	--
TOTAL (rounded) (1)........	53,000	5,500	54,000	4,300
OUTFLOW				
Evapotranspiration (table 8).	80,000	200	80,000	3,800
Subsurface outflow (p. 25)...	--	b 5,300	1,000	--
TOTAL (rounded) (2)........	80,000	5,500	81,000	3,800
IMBALANCE BETWEEN INFLOW AND OUTFLOW (1)-(2)...............	-27,000	(c)	-27,000	500
VALUE SELECTED TO REPRESENT INFLOW AND OUTFLOW....................	75,000	5,500	75,000	4,000

a. About 4,000 from southern Railroad Valley, 2,400 from Little Smoky Valley, and 700 from Hot Creek Valley.

b. Computed as difference between recharge and evapotranspiration. About 1,000 acre-feet per year may go to Kawich Valley; the remainder presumably goes to northern Railroad Valley.

c. Imbalance is zero because one of the budget elements is computed by difference.

CHEMICAL QUALITY OF THE WATER

General Chemical Character

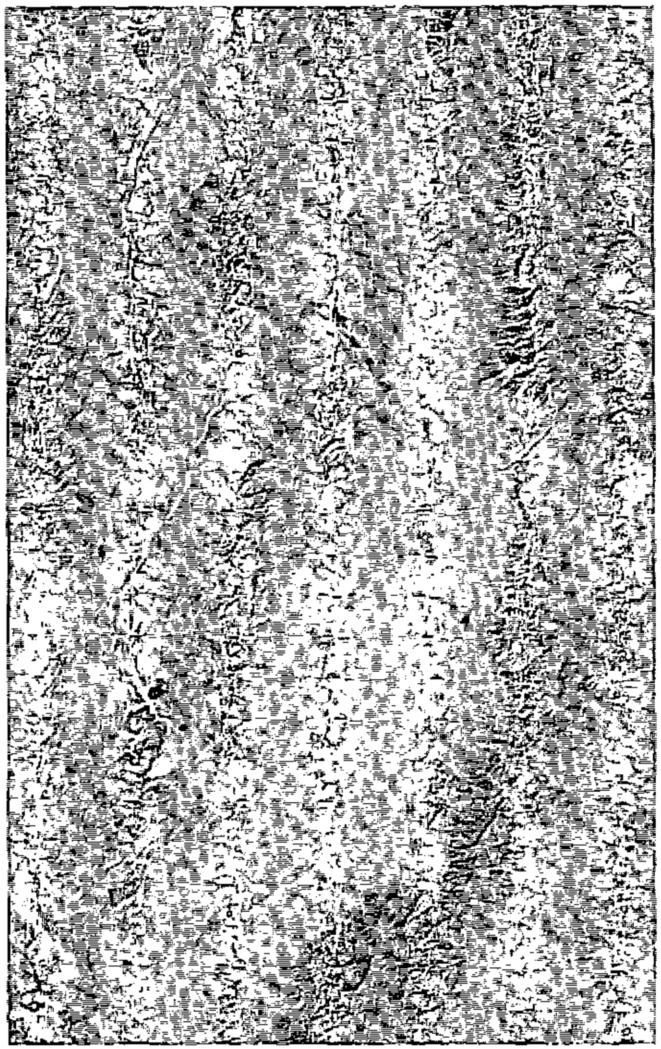
Table 17 lists analyses of water from the study area. The specific-conductance values in table 17 can be used as a preliminary indication of gross chemical content, because the concentration of dissolved solids in a water, in milligrams per liter, is generally 55 to 70 percent of the specific conductance, in micromhos per centimeter at 25°C (hereafter abbreviated "micromhos"). Milligrams per liter are equivalent to parts per million in most waters; see footnote 1, table 17.

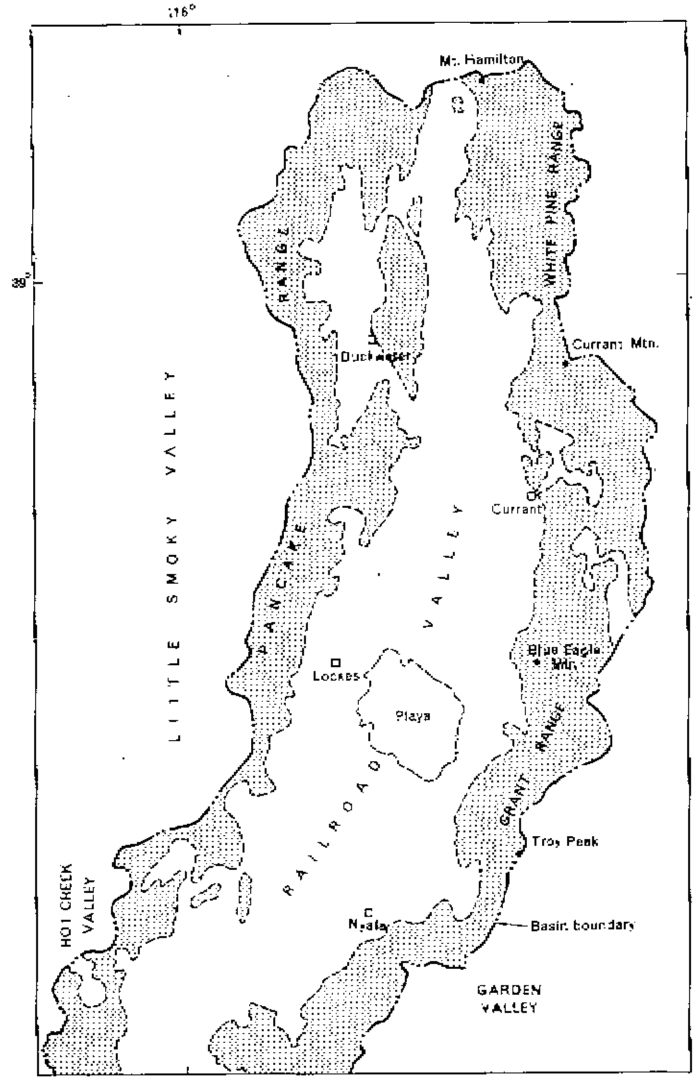
The data in table 17 show that the chemical character of water in the report area is wide in range. The specific conductances of most well waters range from 300 to 800 micromhos, with the lesser values generally for wells (1) that are away from the lowest-lying areas of valley floor, or, in northern Railroad Valley, (2) that penetrate deeper aquifers, at least within the upper 1,000-2,000 feet of valley fill. The tendency to freshen at depth is documented by the data for several pairs of wells, including 8/57-7ca (depth, 55 ft; specific conductance, 699 micromhos) and 8/56-3acb (depth, 550 ft; conductance, 371 micromhos). The same type of situation may also be true of Penoyer and southern Railroad Valleys, but no evidence is available as yet.

Chemically, most of the well waters are dominated by bicarbonate and either calcium or sodium. In northern Railroad Valley, calcium generally exceeds sodium, except at greater depth and beneath or adjacent to the huge playa. Conversely, in southern Railroad Valley, sodium dominates except in the most dilute well waters. The type of consolidated rock in recharge areas surrounding the valley fill probably plays an important role in determining whether calcium (from carbonate rocks) or sodium (from volcanic rocks) dominates. Away from playa areas, concentrations of the other major ions characteristically are below the following values: magnesium and chloride, 30 mg/l (milligrams per liter) each, and sulfate, 70 mg/l. Except near thermal springs, the temperature of water from wells shallower than about 1,200 feet ranges from 50 to 70°F (10°-21°C), with the warmer waters generally associated with the deeper wells. Data from deep oil-exploratory wells southwest of Currant indicate that temperatures increase considerably with depth; for example, the temperature log for well 7/56-2dab (see small graph on pl. 1) shows a maximum reading of 229°F (109°C), at a depth of 10,178 feet.

The flow of nonthermal springs (cooler than about 70°F; 21°C) is chemically similar to the well waters described above.

Water underlying the large playa in northern Railroad Valley is saline (see data for auger hole 9/56-26bad, table 17). In fact, two potash-exploration wells drilled in 1912-13 encountered massive





Photograph 4.--High-altitude vertical view of northern Railroad Valley and adjacent areas. North at top; picture width about 54 miles. (From ERTS-I satellite photograph 81053175405G000, Sept. 14, 1972; multispectral scanner, lower red wavelength range.) Map shows area covered by photograph. Pattern indicates surficial distribution of bedrock within the basin; unpatterned areas indicate alluvium.

beds of the evaporite mineral gaylussite at depths of 781 and 906 feet (wells 7/56-11b and 7/56-22a, table 18), and an oil-exploration well drilled in 1954 by Shell Oil Co. (location, 7/56-2dab; total depth, 10,183 feet) encountered considerable gaylussite between 660 and 2,880 feet, with the greatest quantities in the intervals 861-894 and 1,120-1,130 feet (Horton, 1964, p. 254). The mineral, which has a chemical formula $Na_2Ca(CO_3)_2 \cdot 5H_2O$, represents the evaporative residue from the large lake that occupied the valley many thousands of years ago. Strictly speaking, gaylussite itself is not an evaporite mineral. Instead, it is a rather insoluble alteration product that was derived from a sodium-carbonate-bicarbonate evaporite mineral (perhaps trona). The chemical transformation took place following burial of the evaporites beneath younger lake-bottom sedimentary deposits.

The chemical character of water from consolidated rocks at great depth is wide in range. Water from oil-exploratory wells 7/55-28c, 7/56-2dab, and 8/57-27aac contained only about 500 mg/l of dissolved solids, dominated by sodium and bicarbonate, even at depths as great as 10,000 feet (table 17). In contrast, deep water at and adjacent to the Eagle Springs Oil Field is highly saline and dominated by sodium and chloride (wells 9/57-34add and 35bda4, table 17). This type of water is produced along with oil at the field and is disposed of in settling ponds. Though small in annual quantity, the brine may present a long-term, localized contamination problem. Since the oil field began operation in 1954, brine production may have totaled about 500 acre-feet (through 1971). Assuming an average salinity of 25,000-30,000 mg/l, this volume of brine would have contained 17,000-20,000 tons of salts. The abnormally high chloride content of water from 79-foot domestic well 9/57-35aac (66 mg/l; table 17) suggests that shallow ground water is being affected chemically by the percolating brine. Water from nearby 220-foot well 9/57-35bad3 contains only 7 mg/l, however, indicating that deeper water-bearing zones probably have not been affected, at least as yet.

Thermal springs (warmer than about 70°F; 21°C) in the two valleys are chemically diverse. Specific conductances range from 439 to 1,200 micromhos, with the dissolved solids dominated by bicarbonate and either sodium or calcium. The range in concentration of these and other components is wide. Temperatures are as high as 140°F(60°C), but the three most prolific flows (at Blue Eagle, Duckwater, and Lockes) range from 82 to only about 100°F (28-37.5°C).

Mountain streams in the report area are fed by nonthermal springflow, except during periods of rain or snowmelt runoff. As a result, the streamflow chemically resembles the discharge of nonthermal springs or diluted versions thereof; for example, see the two analyses for Little Currant Creek (11/59-5ba, table 17).

Suitability for Domestic Use

The U.S. Public Health Service (1962, p. 7-8) has formulated standards that are generally accepted as a guideline for drinking waters; in fact, these standards have been adopted by the Nevada Bureau of Environmental Health as regulations for public supplies. The standards, as they apply to data listed in table 17, are as follows:

Constituent	Recommended maximum concentration (milligrams per liter)
Iron (Fe)	0.3
Manganese (Mn)	.05
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	a/ About 1.2
Nitrate (NO_3)	45
Dissolved-solids content	b/ 500

a. Based on an annual average maximum daily air temperature of about 65°F (18½°C). The optimum fluoride concentration is about 0.9 mg/l. Water containing more than about 1.8 mg/l should not be consumed regularly, especially by children.

b. Equivalent to a specific conductance of about 750 micromhos.

Most of these are only recommended limits, and water therefore may be acceptable to many users despite concentrations exceeding the given values. Excessive iron or manganese causes staining of porcelain fixtures and clothing, and impairs the taste of beverages. Large concentrations of chloride and dissolved solids also impart an unpleasant taste, and sulfate can have a laxative effect on persons who are drinking a particular water for the first time. Excessive fluoride tends to mottle teeth, especially those of children, and a large amount of nitrate is dangerous during pregnancy and infancy because it may increase the possibility of "blue-baby" disease.

The arsenic content of drinking water is particularly important because of the possibility of cumulative poisoning. The U.S. Public Health Service (1962, p. 8) states that arsenic should not exceed 0.05 mg/l in drinking water.

The bacteriological quality of drinking water also is important, but is outside the scope of this report.

The hardness of a water is of concern to many users. Therefore, the U.S. Geological Survey has adopted the following rating:

Hardness, as $CaCO_3$ (milligrams per liter)	Rating and remarks
0-60	Soft (suitable for most uses without artificial softening)
61-120	Moderately hard (usable except in some industrial applications; softening profitable for laundries)
121-180	Hard (softening required by laundries and some other industries)
More than 180	Very hard (softening desirable for most purposes)

The data in table 17 suggest that generally suitable water is available throughout much of each valley, but that problem areas do exist. In Penoyer and northern Railroad Valleys, for example, many waters are hard or very hard. In southern Railroad Valley, the more concentrated waters are soft or only moderately hard, but contain excessive fluoride. Soft, fluoride-bearing waters also are characteristic of deep aquifers adjacent to the central playa in northern Railroad Valley. Most of the thermal springflow also contains excessive fluoride, and is hard or very hard. Constituents that are not a problem, except in a few local areas, include iron, manganese, sulfate, chloride, nitrate, and dissolved-solids content. No arsenic analyses are known to have been made for water in the report area.

If any doubt exists regarding the acceptability of a specific water supply for domestic use, contact the Nevada Health Division's Bureau of Environmental Health, Carson City.

Suitability for Agricultural Use

In evaluating the desirability of a water for irrigation, the most critical considerations include dissolved-solids concentration, the proportion of sodium relative to calcium plus magnesium, and the abundance of constituents such as boron that can be toxic to plants. Four factors used by the U.S. Salinity Laboratory Staff (1954, p. 69-82) to evaluate the suitability of irrigation water are listed in table 18, and are discussed briefly in footnote 2 of that table.

Minor amounts of boron (up to about 0.5 mg/l) are essential to plant nutrition, but larger concentrations can be highly toxic. The approximate upper limits recommended for boron in water irrigating sensitive, semitolerant, and tolerant crops are, respectively, 0.5-1.0, 1.0-2.0, and 2.0-4.0 mg/l (National Technical Advisory Committee, 1968, p. 153).

Except beneath and immediately adjacent to the three playas, almost all water sampled in the report area is chemically suitable for irrigation.

Most animals are more tolerant of poor water than man. Although available data are somewhat conflicting, a dissolved-solids content less than 4,000-7,000 mg/l (equivalent to a specific conductance of about 6,000-10,000 micromhos) apparently is safe and acceptable (McKee and Wolf, 1963, p. 112-113), provided that undesirable constituents are not present in excessive concentrations. Thus, almost all sampled water within the study area is sufficiently dilute for livestock.

AVAILABLE GROUND-WATER SUPPLY

The available ground-water supply in the report area consists of two interrelated quantities: The perennial yield and the transitional storage reserve.

Perennial Yield

The perennial yield of a ground-water reservoir may be defined as the maximum amount of water of adequate quality that can be withdrawn and consumed economically each year for an indefinite period. If the perennial yield is continually exceeded, water levels will decline until the usable ground water is depleted or until the pumping lifts become uneconomical to maintain. Perennial yield cannot exceed the natural recharge to an area, and ultimately is limited to the maximum amount of natural discharge that can be salvaged for beneficial use. This salvage implies diversion of ground water presently destined for areas of natural discharge, including outflow, to areas of pumping. The diversion can be accomplished by lowering water levels in and near areas of natural discharge, utilizing the transitional storage reserve, as discussed below.

The estimated perennial yields for valleys in the report area are listed in table 10. Southern Railroad Valley apparently loses about 5,300 acre-feet of ground water per year as underflow to northern Railroad and Kawich Valleys, by way of consolidated rock as well as valley fill. Presumably, only part of the outflow could be salvaged by pumping; for this reconnaissance, the feasible salvage is assumed to be about half the outflow. However, if all or part of this quantity is salvaged in the upgradient valley, that amount can no longer be considered available in the downgradient valleys. Nonetheless, because the pattern of future development is not known, the salvable part is included in the perennial yields of both contributing and receiving valleys to determine the maximum yield of each.

Transitional Storage Reserve

The transitional storage reserve has been defined by Worts (1967, p. 50) as the quantity of ground water in storage that can be extracted and beneficially used during the period of transition between natural equilibrium conditions and new equilibrium conditions under the perennial-yield concept of ground-water development. Thus, the transitional storage reserve is a specific part of the ground-water resource; it is a quantity that is available in addition to the annual recharge, but it can be withdrawn from storage on a once-only basis unless replenished.

Ground-water development inherently involves storage depletion. The magnitude of depletion depends upon the amount of pumpage, the hydraulic characteristics of the aquifer, and the location of wells with respect to recharge and discharge boundaries.

Table 10.--Preliminary estimates of perennial yield

Valley	Estimated perennial yield (acre-feet)[1]	Assumptions regarding quantities salvaged (see table 9)
RAILROAD		
Northern part	75,000	All evapotranspiration.
Southern part	2,800	All transpiration, plus about half of subsurface outflow.
Entire valley (rounded)	a 75,000	All evapotranspiration, plus about half of subsurface outflow to Kawich Valley.
PENOYER	4,000	All transpiration.

1. The generally poor quality of ground water beneath the playas may limit development.

a. Perennial yield for entire valley is less than summation of yields for northern and southern parts. Summation would incorrectly count some water twice, because evapotranspiration in northern part is fed in part by subsurface inflow from southern part.

Computation of the transitional storage reserve for valleys in the report area is based on the following assumptions. (1) Development wells would be strategically located in or near the areas of natural discharge, so that any subsurface outflow could be reduced and any evapotranspiration stopped with a minimum of water-level drawdown in the pumped wells. (2) In general, water levels would be lowered to and stabilized at a depth 50 feet below the land surface in areas of phreatophyte growth, which would curtail virtually all evapotranspiration from the ground-water reservoir. (3) Long-term pumping would cause a moderately uniform depletion of storage throughout the valley-fill reservoir, except possibly in the very fine-grained playa deposits, where transmissibility and storage coefficients are small. (4) The specific yield of the valley fill is about 10 percent. (5) Water levels are within the range of economic pumping lift for the intended use. (6) The pumping development causes little or no effect on adjacent valleys. (7) The water is of suitable quality for the desired use.

Table 11 lists the preliminary estimates of transitional storage reserve for the report area. For each valley, the estimated reserve is the product of (1) the area beneath which storage depletion is expected, (2) the average thickness of valley fill that must be

Table 11.--Preliminary estimates of transitional storage reserve

Valley	Selected area of depletion (acres)1/	Selected thickness of depletion (feet)	Transitional storage reserve (acre-feet, except as indicated by footnote)
RAILROAD			
Northern part	600,000	50	a 3,000,000
Southern part	200,000	b 20	c 20,000 d 400,000
PENOYER	220,000	35	770,000

1. Assumed to be about 80 percent of alluvial areas listed on p. 10, because of inward-sloping contact between valley fill and consolidated rocks, and because some alluvial areas may be underlain at shallow depth by pediments.

a. Includes about 200,000 acre-feet of saline water beneath playa.

b. Thickness required to salvage about half of the subsurface outflow (table 10) is unknown, but a lowering of about 20 feet would stop all transpiration loss.

c. Transitional storage reserve per foot of dewatered thickness.

d. Amount of stored water to be removed to stop all transpiration.

dewatered to eliminate evapotranspiration losses or to salvage part of the ground-water outflow (except as indicated by footnotes a and b), and (3) an assumed specific yield of 10 percent.

The manner in which transitional storage reserve augments the perennial yield has been described by Worts (1967, p. 52), and is shown in its simplified form by the following equation:

$$Q = \frac{\text{Transitional storage reserve}}{t} + \frac{\text{Perennial yield}}{2}$$

in which Q is the pumping rate, in acre-feet per year, and t is the time, in years, required to exhaust the storage reserve. This basic equation can be modified to allow for changing rates of storage depletion and salvage of natural discharge, but it is not valid for pumping rates less than the perennial yield.

The equation can be used to estimate the time (t) necessary for depletion of the transitional storage reserve in a particular valley. Using the above equation and the estimates for northern Railroad Valley as an example (transitional storage reserve 3,000,000 acre-feet, table 11; perennial yield about 75,000 acre-feet, table 10) and using a pumping rate, Q, equal to the perennial yield, the time, t, to deplete the transitional storage reserve is computed to be about 80 years.

What the above equation does not indicate is that in the first year of transition, virtually all pumpage would be supplied from storage, and very little, if any, would be derived by salvage of natural discharge. On the other hand, during the last year of the period, nearly all pumpage would be derived by salvage, with virtually none from the storage reserve.

During the period of depletion, the directions of ground-water flow in the valley would be modified substantially. Ground water that originally flowed from the peripheral areas of recharge to the central area of natural discharge would ultimately flow directly to the pumping wells.

The above equation can be used to compute the time required to exhaust the storage reserve for any selected pumping rate in excess of the perennial yield. However, once the transitional storage reserve is exhausted, the pumping rate would have to be reduced to the perennial yield to avoid an overdraft and a continued increase in pumping lifts.

FUTURE DEVELOPMENT

Present-day (1972) development of water resources in the study area is small: consumptive use for agricultural, domestic, waterfowl, and industrial purposes in Railroad Valley is only about 17,000 acre-feet per year, compared with a total perennial yield of 75,000 acre-feet. Properly planned additional farming might be successful, provided that soils are suitable or can be made suitable with relative ease (see Summerfield and Peterson, 1971, for an excellent discussion of the soils in Railroad Valley). According to Summerfield and Peterson (p. 10, 28), the average growing season at Diablo Maintainance Station, in southern Railroad Valley (altitude, 5,000 ft), is approximately 150 days for a 32°F (0°C) frost. However, the season on lower parts of the valley floors probably is shorter because of cold air drainage from higher altitudes at night. Similarly, the season may be shorter in the northern part of Railroad Valley because of higher altitude and more northerly latitude.

A possible future use involves the development of ground water in Railroad Valley as a supplemental supply for the Las Vegas metropolitan area, about 150 miles to the south. Although the estimated unit cost for importation from Railroad Valley is higher than the costs for most other alternative plans (Blackmer, 1970, p. 39), the possibility may receive further consideration as Las Vegas water needs grow.

Brine disposal at the Eagle Springs Oil Field will continue to contaminate shallow ground water locally in areas downgradient from (presumably southwest of) the disposal ponds. The ultimate extent and degree of contamination, both areally and vertically, are difficult to predict, but could be monitored with an appropriate array of observation wells.

NUMBERING SYSTEM FOR HYDROLOGIC SITES

The numbering system for hydrologic sites in this report indicates location on the basis of the rectangular subdivision of public lands, referenced to the Mount Diablo base line and meridian. Each number consists of three units: the first is the township north or south of the base line; the second unit, separated from the first by a slant, is the range east of the meridian; the third unit, separated from the second by a dash, designates the square-mile section. The section number is followed by letters that indicate the quarter section, quarter-quarter section, and so on; the letters a, b, c, and d designate the northeast, northwest, southwest, and southeast quarters, respectively. For example, well 8/56-26bad is in SE¼NE¼NW¼ sec. 26, T. 8 N., R. 56 E. Sites in townships south of the base line are indicated with an "S" following the township number (for example 1S/53-28bda); location numbers north of the base line have no letter following the township number.

In this report, most sites identified with three letters are in areas where detailed U.S. Geological Survey topographic mapping (scale, 1:62,500) is available. In other areas, sites have been located using aerial photographs and a less detailed 1:250,000-scale map. An index to Geological Survey topographic maps in Nevada can be obtained free of charge from the Geological Survey, Federal Center, Denver, Colo. 80225.

Because of space limitation, wells and springs are identified on plate 1 only by section number and quarter-section letter. Township and range numbers are shown along the margins of the report area.

WELL AND SPRING DATA

Information regarding selected wells and springs is listed in the tables that follow. Included are well data (table 12), well logs (13), water-level measurements in observation wells (14), spring data (15), discharge measurements for four of the largest springs (16), and chemical analyses (17).

More than 30 oil exploration wells have been drilled in Railroad Valley outside the Eagle Springs Oil Field. Logs of various types, including lithologic and induction-electric, are available for many of these wells, and for most wells in the oil field (Schilling and Garside, 1968). The data are on file with the Nevada Oil and Gas Conservation Commission, Nevada Bureau of Mines and Geology office, Reno, Nev.

Table 12.--Well data

Location: An asterisk following the location number indicates that the well was not visited during the present study, and that the exact location is uncertain.

Depth: Depths followed by asterisk were measured by U.S. Geological Survey personnel at time of water-level measurement; all others are reported depths.

Use: D, domestic; E, exploratory; I, industrial; Ir, irrigation, S, stock; U, unused or abandoned (intended or former use in parentheses).

Land-surface altitude: Altitudes determined by altimeter, or indicated on post-1960 topographic maps, are followed by an asterisk. Other altitudes are estimated using topographic maps or reported data. Altitudes listed here do not necessarily agree with the less accurate topographic contours shown in plate 1 (see "Physiographic Setting" in text).

Water level: Measurements recorded to tenths or hundredths of a foot were made by U.S. Geological Survey personnel, and represent depth below land-surface datum; most measurements recorded to nearest foot were reported by well driller or owner.

Remarks: C, chemical analysis in table 17; F, depth, in feet, at which water was first encountered during drilling; L, driller's log in table 13, or in reference indicated ("Bull. 12" refers to Eakin and others, 1951, table 9; see "References" section); O, USGS observation well; R, reported well depth when drilled; S, log in files of State Engineer (State log number is indicated); T, length of time between start of pump test and measurement of drawdown, in hours.

Location	Owner and(or) name	Year drilled or dug	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Land surface altitude (feet)	Water-level measurement: Depth (feet)	Water-level measurement: Date measured	Remarks
					RAILROAD VALLEY					
18/51½-23bc	Joe Fallini (Willow Witch well)	1959	370	6	S	--	5,930	335	10- -59	F=335; S=3084; L.
15/53-20bda	Joe Fallini (Deep well)	1950	465	6	S	--	5,205*	418 414.67	10- -50 3-29-72	F=420; S=1672; L, C.
1/53-3dac	Joe Fallini (East Side well)	--	120	6	S	--	4,851*	68.74	3-30-72	C.
-7adc	Joe Fallini (new Fred's well)	--	136*	6	S	--	4,856*	See table 14		C.
-27bba	Joe Fallini (Last Stand well)	1948	200	6	S	--	4,788*	180 172	1948 3-30-72	F=180; S=792; L (Bull. 12); C.
-31dcc	Joe Fallini (Pyramid well)	1951	272	5	S	12/--	5,024*	205	11- -51	F=220; S=1804; C. Perforations, 205-272 ft.
-32db	Nevada Dept. of Highways	1957	292	8	D,I	--	5,004*	225	5- -57	F=245; S=3772; L.
2/53-23cbc	Joe Fallini (Sunrise well)	1962	180	6	S	--	4,892*	100(?) 112.78	9- -62 3-29-72	F=110; S=6777; L; C.
3/53-35bac	Joe Fallini (Ed's well)	pre-1943	204	6	S	--	4,942*	163	3-29-72	C.
3/54-5bc	Norman and Gerald Sharp (Goat Ranch well)	1948	325	6,4	S	--	5,040*	265	11- -48	F=300; S=757; L (Bull. 12); C.
4/54-18dc	Ed Casey (Butler well)	1948	150	5	S	--	4,911*	130 a 137.41	8- -48 11-28-67	F=130; S=671; L (Bull. 12).
4/55-19da	Norman and Gerald Sharp	1951	255	6	S	--	5,000±	215 213.61	6- -51 10- 9-71	F=221; S=1704; L; C.
5/54-24dcb	Ed Casey (Fergy well)	1951	100	6	S	--	4,825*	52 54.83	8- -51 10- 9-71	F=60; S=1741; L.
-34dab	Ed Casey (Stone Corral well)	1948	110	5	S	--	4,848*	80 a 82	8- -48 11-28-67	F=90; S=670; L (Bull. 12, but listed in sec. 32).
5/55-15cd*	--	1960	70	--	E	--	4,785	19	1960	L.
-27cbb	Mrs. A. B. Gibson	1964	250	18	U(Ir)	5,000/--	4,795	31	6- -64	F=40; S=9650. Perforations, 80-230 ft; temp. 59°F (15°C).
-27cbc	H. T. Gibson	1965	245	18	U(Ir)	2,500/--	4,795*	31	5- -65	F=65; S=8793. Perforations, 70-245 ft; temp. 60°F (15.5°C).
-28dbb	Amy Collins	1964	219	16	U(Ir)	--	4,799*	38	2- -64	F=45; S=7877, L.
-32bbd	Warren	--	240	--	Ir	--	4,820*	--	--	S=0785; L; C.
-33bbc	W. B. Gibson	1965	249	18	U(Ir)	5,000/--	4,805	33	4- -65	F=80; S=8792, 10389. Perforations, 70-249 ft; temp. 59°F (15°C).
-33ddd	Mrs. A. B. Gibson	1965	396	18	U(Ir)	--	4,820±	55	8- -65	S=8789, L. Temp., 59°F (15°C).
-34aba	Norman and Gerald Sharp	1951	75	6	U(S)	50/--	4,797*	27 30.29	6- -51 10-13-71	F=20; S=1649. Perforations, 35-75 ft; temp. 50°F (10°C).
-34cdd	W. B. Gibson	1965	398	16,12	Ir,D	--	4,820*	72 67.42	7- -65 10-13-71	S=7975, 8794; C. Well originally 220 ft deep, with water level at 65 ft in Feb. 1964. Perforations, 75-398 ft.
-34ddd	Norman and Gerald Sharp	1965	395	16,12	Ir	1,800/--	4,820±	69	10- -65	F=80; S=8791. Perforations, 155-395 ft; temp. 60°F (15.5°C).
-35bdd	do.	1965	320	16	Ir	--	4,815±	55	10- -65	F=53; S=9838. Perforations, 160-320 ft; temp. 60°F (15.5°C).
-35cdd	do.	1964	320	16	Ir	1,200/--	4,840±	75	3- -64	F=77; S=8882. Temp., 60°F (15.5°C).
-36dad1	do.	1951	105	8	S	100/--	4,900±	50(?)	6- -51	F=60; S=1650, C. Perforations, 60-105 ft; temp., 50°F (10°C).
-36dad2	do.	1965	179	16	U(Ir)	--	4,900±	50(?) 60.61	11- -65 10-13-71	F=50; S=8790; L. Perforations, 60-179 ft; temp., 60°F (15.5°C).
6/55-22dd*	U.S. Bureau of Land Management (Nyala well no. 1)	--	31	6	U(S)	--	4,750	--	--	
6/56-5aac	U.S. Bureau of Sport Fisheries and Wildlife ("old well no. 7")	1912	755	6	W	Remarks	4,712	Flows	10-13-71	L (Bull. 12); C. Flow 180-235 gpm in 1934-35; 120-180 gpm on 10-13-71.
-14dcd	Sharp partnership	1962	285	8	S,Ir	100/--	4,760	Flows	5- -62	S=10535.
-18dbd	U.S. Bureau of Land Management (Nyala well no. 2)	1960	131*	6	S	40-45/--	4,735	Flows	10-13-71	C.
-27acb	Sharp partnership	1962	98	8	S,Ir	100/--	4,768	Flows	10- 6-71	S=10709; L; C. Flow measured 4-62. Flow of adjacent 100-ft well -27bdd 40-50 gpm (measured), 13.0°C, on 3-31-72.
6/57-6ddd	Gulf Oil Corp.	1967	150	6	U(I)	--	4,780	22	11- -67	S=9912; L.
7/55-28ca	Shell Oil Co.	1955	46	6	U(I)	20/--	4,727	Flows	8- -55	S=3128; L (includes data to 1,711 ft from adjacent oil expl. hole); C.
7/56-1dd*	U.S. Bureau of Sport Fisheries and Wildlife ("old well no. 3")	1912?	770	--	U	19/--	4,709	Flows	2- 7-34	L (Bull. 12).
-2daa	Shell Oil Co.	1954	285	6	U(I)	3/--	4,712	--	--	S=2967; L.
-2dab	do.	1954	10,103	--	U(E)	--	4,709	--	--	C. Temperature log shown on pl. 1.

Table 12.--Well data--Continued

Location	Owner and(or) name	Year drilled or dug	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Land surface altitude (feet)	Water-level measurement Depth (feet)	Date measured	Remarks
7/56-3ccb1	U.S. Bureau of Sport Fisheries and Wildlife ("old well no. 5")	1912?	795	--	U	--	4,707	Flows	1934?	L (Bull. 12). Basalt encountered at 794 ft.
-3ccb2[a/]	Unknown	--	29	4	U	--	4,707	4.62	7-18-69	May be uncaved remainder of well 3ccb1.
-10cb	Gulf Oil Corp.	1967	425	8,6	U(I)	9/325	4,707	--	--	T=2; S=9846; L. Sulfide odor; water too salty for use in drilling oil expl. well.
-10ddd	U.S. Bureau of Sport Fisheries and Wildlife ("old well no. 4")	1912?	762	--	U	--	4,708	--	--	L (Bull. 12; listed in sec. 11). Scattered gaylussite below 716 ft.
-11b*?	do. ("old well no. 2")	1912	841	--	U	--	4,708	--	--	L (Bull. 12). Scattered gaylussite below 718 ft; massive below 781 ft.
-22a*	do. ("old well no. 6")	1913?	990	--	U	--	4,708	--	--	L (Bull. 12). Scattered gaylussite below 796 ft; massive below 906 ft.
7/57-4acc	Shell Oil Co.	1961	7,485	--	U(E)	--	4,720	--	--	L.
-4dbb	do.	1961	60	6	U(I)	--	4,720	0	8- -61	P=30; S=6081; L.
-5caa	do.	1961	85	6	U(I)	--	4,711	10?	11- -61	P=50; S=6243; L.
-17ba	Gulf Oil Co.	1968	310	6	U(I)	--	4,715	--	--	S=10178; L.
-21aa*	U.S. Bureau of Land Management (Lake well)	1969	150	6	S	23/5	4,760?	1	6- -69	T=2; P=9; S=10631; L.
8/55-24a*	U.S. Bureau of Sport Fisheries and Wildlife ("new well no. 1")	1934	600	8,6	W	55-115/--	4,714	Flows	1934-35	L (Bull. 12). Flow measured in 1934-35.
8/56-2cba	do. ("new well no. 4")	1934	400	6,4	W	153-192/--	4,732	Flows	1934-35	Do.
-2dac	do. ("old well no. 1;" known as "Big well")	1912	1,204	10	W	Remarks	4,734	Flows	10-10-71	L (Bull. 12); C. Flow 206-234 gpm in 1934-35; 250 gpm on 9-17-45; 191 gpm on 5-20-52; 75-95 gpm on 10-10-71 (67°F, 19.5°C).
-3acb	do. ("new well no. 3")	1934	550	6	W	Remarks	4,731	Flows	10-10-71	L (Bull. 12); C. Flow 100-159 gpm in 1934-35; 60-70 gpm on 10-10-71.
-3dbb	Shell Oil Co.	1955	7,324	--	U(E)	--	4,732	--	--	L.
-26bad	Augered by U.S. Geological Survey	1971	8	4	E	--	4,709	7.2	10-11-71	L; C.
8/57-7a*	U.S. Bureau of Sport Fisheries and Wildlife ("new well no. 6")	1935	635	6	W	110-125/--	4,738	Flows	5-30-35	L (Bull. 12). Flow measured in 1935.
-7ca	A. P. Sutherland	1971	55*	8	U(T)	--	4,727	1.92	10-11-71	C.
-14ac*	Carl Hanks	1951	185	14	Ir	600/--	4,750-60	Flows	8- -51	P=4; S=1724; L. Temp. 71°F (21.5°C).
-22cdc	Shell Oil Co.	1955	43*	6	U(I)	20/--	4,730	2.70	10- 6-71	R=60; P=1; S=3291; L; C.
-27acc	Shell Oil Co.	1954	6,038	--	U(E)	--	4,745	--	--	C. Valley fill penetrated to 5,194 ft; consolidated rocks below.
-27dda*	Carl Hanks	1951	220	6	D	--	4,760?	12	7- -51	S=1725. Perforations, 12-175 ft; temp. 68°F (20°C).
8/59-33*	U.S. Bureau of Land Management (new Wells Sta. well)	1967	100	6	S	1/--	6,400±	65?	5- -67	P=50; S=9528; L.
9/56-14bda	LeRoy Sharp (Trapp Spring well)	1964	101*	8	S	--	4,779*	1.5 1.10	3- -64 10-10-71	R=110; C.
-34cac	U.S. Bureau of Sport Fisheries and Wildlife ("new well no. 2")	1934	700	8	W	Remarks	4,731	Flows	6-12-35	L (Bull. 12). Flow 90 gpm, 57°F (14°C) on 6-17-68[a/]; 93-132 gpm in 1934-35.
-35cda	do. ("new well no. 5")	1935	550	6	W	Remarks	4,732	Flows	6-12-35	L (Bull. 12). Flow 36 gpm, 60°F (15.5°C) on 7-18-69[a/]; 43-55 gpm in 1935.
9/57-1abb	A. M. Whitsett, Jr.	1954	200	14	Ir	1,000/26	4,930	130 131.03	8-11-54 10-12-71	P=132; S=2679; L.
-2bab	R. M. Otis	1954	92*	6	U(D)	--	4,867*	78? 68.52 69.98	6- -54 11-11-56 10-12-71	R=100; P=90; S=2589. No perforations.
-6dab	Federal Aviation Administration	1963	141	4	D	1/--	4,802	7½ 10.45	6- -63 10-11-71	P=7½; S=7340; L; C.
-12ab*	Ole Dillard	1964	220	16	U(Ir)	--	4,880?	100	1965	P=130; S=8714.
-20cab	LeRoy Sharp (Gravel Ridge well)	--	219*	6	S	Remarks	4,760	Flows	10- 6-71	C. Flow 3.6 gpm on 7-19-69[a/]; 0.2 gpm on 10-6-71.
-34add	North American Resources Corp.	1967	8,694	--	I	--	4,747	--	--	C. Valley fill penetrated to 7,145 ft; consolidated rocks below.
-34bb*	Shell Oil Co.	1956	50	6	U(I)	25/11	4,750	4	1- -56	P=5; S=3336. Penetrated sand and gravel, with only 10% clay.
-35aac	North American Resources Corp.	1955?	79*	6	D,I	--	4,759	4.9 3.3	10-12-71 4- 1-72	C.
-35bad1	Shell Oil Co.	1953	60	6	U(I)	65/0	4,753	15	12- -53	S=2969. Perforations, 40-60 ft.
-35bad2	do.	1953	200	6	U(I)	--	4,753	24	12- -53	S=2968; L.
-35bad3	--	--	220±*	6	S(I)	--	4,755	Flows	3-31-72	C.
-35bad4	Shell Oil Co.	1954	10,358	--	I	--	4,754	--	--	L; C. First oil-producing well in Nevada.
9/58-18bca	Blue Eagle well	--	--	6	S	--	4,838	52.79	10- 6-71	
9/59-5d	Calloway well	--	44*	40	S,D	--	5,900±	37.12 38.6	4-18-48 6-19-57	

Table 12.--Well data--Continued

Location	Owner and(or) name	Year drilled or dug	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Land surface altitude (feet)	Water-level measurement Depth (feet)	Date measured	Remarks
10/57-12dda	Wayne McLarty	1966	401	16,14	Ir,D	1,050/--	5,050	184 177.74	11- -66 10-12-71	S=9336, 9364; L. Well originally 220 ft deep, with water level 113 ft (11-65).
-13baa	Joe Bailey	1967	335	16	U(Ir)	400/--	5,020	--	--	F=148; S=10031. Perforations, 148-335 ft.
-13cba	do.	1967	370	16	U(Ir)	1,030/--	4,990	160?	9- -67	S=10822. Perforations, 160-368 ft.
-14aaa	Bill Farmer	1966	526	16	U(Ir)	--	4,990	145.62	4- 1-72	S=9137, 9399. Perforations, 170-250 ft, with open-ended casing at 250 ft. Water level was at 114 ft prior to deepening from 250 ft to 526 ft.
-15aaa	Karl Hall	1968	200	16	U(Ir)	680/--	4,945	83.06	10-12-71	F=105; S=9932; L.
-15add	Charles Wilson	1970	251	16	U(Ir)	1,570/--	4,940	80	4- -70	F=88; S=11008; C. Perforations, 88-240 ft.
-23aaa	B. K. Bridges	1966	358	16	U(Ir)	1,580/--	4,960	158 156.63	7- -66 10-12-71	F=166; S=9338. Perforations, 166-304 ft.
-25abc	Bandini Petroleum Co.	1954	5,556	--	U(E)	--	4,990	--	--	L.
-27aaa	Leon Watson	1969	200	16	U(Ir)	2,450/--	4,900	68 70.40	5- -69 10-12-71	F=35; S=11406; L.
-30c*	Cth Campbell?	--	15*	48	U	--	4,830±	7 measurements between 7-1-48 and 9-18-53 ranged from 10.94 to 11.61 ft.		
-32bbb	do.	--	348	6	U	--	4,827	Flows	4-25-48	L (Bull. 12); C. Flow 110 gpm on 2-5-35; 480 gpm on 4-25-48 after clean-out; 250-350 gpm on 8-7-67.
10/59-16	U.S. Bureau of Land Management (Menzonie well)	1942	96	6	U(S)	--	6,280±	--	--	L.
11/55-2??*	Ed Halstead	--	17	—	S	--	6,500±	9.9	11-10-56	
11/56-2adc	do.	1959	250	14	U(Ir)	880/103	5,095	29 38.75	12-17-59 10-12-71	T=3; F=28; S=5718; L.
11/57-9cd	U.S. Bureau of Land Management (Bull Ck. well no. 1)	1942	354	6	S	--	5,072*	See table 14		
11/59-16ba	Nevada Dept. of Highways	1968	290	10,6	D	40/20	6,300	87	7- -68	T=4; S=9958, 10162; C. Cased to 140 ft; perforations, 50-140 ft; principal water-bearing zone coarse gravel, 50-60 ft.
12/55-25cd	U.S. Bureau of Land Management (W. Duckwater well)	1958	289	6	S	--	5,672*	230 205.77	1- -58 10- 5-71	F=240; S=4000; L.
12/56-34cba	Copper Sheep Co.	1959	202	14	U(Ir)	--	5,200	7	10- -59	F=29; S=5072; L.
12/57-9bcb	U.S. Bureau of Land Management (Bull Ck. well no. 2)	1943	356	6	S	--	5,500	a 277.35 271.66	6-18-68 10- 5-71	C.
13/56-19dcb	--	--	85	6	U(D)	--	5,575	81	--	
-29cba	--	1971	103*	6	D	--	5,600	26.57	10-12-71	
14/55-12bdb	U.S. Bureau of Land Management (Poison Patch well)	1956	400*	6	U	--	5,930	Dry	9-23-57	L.
14/56-19bcb	--	--	226±*	6	U	--	5,820	204.70	4- 2-72	
15/55-21?*	U.S. Bureau of Indian Affairs	1951	271*	--	U	--	6,300±	Dry	9-23-57	
15/57-17dcd	U.S. Bureau of Land Management (Cathedral well)	1944	221*	6	U(S)	--	6,090	204.86 201.88 208.13	4-29-48 8-17-56 10- 5-71	R=355.
-32ba*	H. L. Martin	1969	280	16	Ir	30/0	6,040±	171	6- -69	F=180; S=11071; L.
16/57-20da*	Shell Oil Co.	1956	350	6	U(E)	8/--	7,500±	215	8- -67	S=10158. Perforations, 310-340 ft. Water temp. 65°F (19.5°C).
					PENOYER VALLEY					
18/55-22a	--	--	--	--	S	--	5,050*	287.00	10- 7-71	
28/55-17dc	Honest John well	--	--	--	S	--	5,010*	249.78	10- 7-71	
28/56-3dc	Shadow well	--	--	6	S	--	4,850*	95.91	10- 7-71	
-6ad*	Burns Ranch	1970	120	6	S	--	--	85	1970	S=11207; L.
38/54-24ac	R. M. Marion	1967	327	18,16	U(Ir)	--	4,860*	113 118.10	1967 10- 7-71	S=9608; L.
-24bc	R. G. Marion	1964	251	16	U(Ir)	--	4,885*	145 146.15	1964 10- 7-71	S=7679. Chief aquifer 145-251 ft.
-25b1	Southwestern well	--	165	6	S	--	4,880*	141.91	7- 1-48	
-25b2*	J. H. Gray	1967	435	16,14	U(Ir)	2,400/48	4,900	168	1967	S=9491; L.
38/55-5bd	Black Rock well	--	20	8	S	--	4,760*	18.75 19.16	5- 5-48 10- 7-71	
-7cc	--	--	--	8	S	--	4,850*	106.57	11-20-69	
-19cc	N. J. Gunderson	1963	238	12	Ir	--	--	102	1963	S=9890. Chief aquifer 138-238 ft. Water temp. 83°F (28.5°C).
-23dc	Number 6 well	--	--	6	S	--	4,780*	27.68 29.30	11-20-69 10- 7-71	C.
-28dc	D. C. Day	--	250?	16	U(Ir,D)	--	4,835*	87.30	10- 7-71	
-29	Herbert Cose	1961	300	16	D,I	1,000/--	--	76	1961	F=76; S=6078; C. Chief aquifer 90-300 ft.
-30bc	E. W. Gunderson	1964	240	14	U(Ir,D)	2,150/--	4,870	113	1964	F=113; S=8028. Chief aquifer 113-240 ft. Logged only sand and gravel.
-31dc*	F. J. Hansen	1966	250	16	U(Ir)	2,500/95	4,890	135	1966	S=9175. Chief aquifer 135-250 ft. Logged only sand and gravel.

Table 12.--Well data--Continued

Location	Owner and(or) name	Year drilled or dug	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Land surface altitude (feet)	Water-level measured: Depth (feet)	Water-level measured: Date measured	Remarks
38/55-32cc*	C. F. Pogue	1960	157	14	D(Ir,U)	500/—	—	117	1960	F=117; S=5737. Chief aquifer 117-157 ft. Logged only sand and gravel.
-33cc*	Addie Hasterler	1964	303	16,14	U(Ir)	--	4,870	114	1964	F=114; S=7866. Chief aquifer 190-245 ft. Logged only sand and gravel.
-34cc*	Johanna Wackerle	1966	537	16	U(Ir)	2,500/57	--	70	1966	F=70; S=9511. Chief aquifer 465-490 ft.
-35dd*	R. T. Baker	1968	271	16	U(Ir)	--	--	110	1968	S=9848.
-36ad	--	--	--	8		--	4,870	137.90	10- 7-71	
38/56-6ca	Buttes well	--	--	8	S	--	4,763*	27.74	10- 7-71	
-17dc	--	--	--	--	U(Ir,U)	--	4,845	103.83	10- 7-71	C.
45/55-2cd	--	--	—	6	S	--	4,897*	142.70	11-20-69	
-3cc*	W. W. Pidcoe, Jr.	1965	208	16	U(Ir)	--	--	120	1965	F=131; S=8892. Chief aquifer 189-208 ft.
-4c1	--	--	—	6	U(S)	--	4,870	111.22 122.80	11-20-69 10- 7-71	
-4c2	--	1970	400	16,12	U(Ir)	2,200/206	4,880	136	1970	S=11130. Deepened from 235 ft. Chief aquifer 260-400 ft.
-5cb	G. C. Englemann	1966	250	16	U(Ir)	2,500/442	--	185	1966	F=186; S=8906. Chief aquifer 240-250 ft. Warm water. Nearly all sand and gravel.
-7bc*	Burns Ranch	1965	240	6	S	--	--	195	1965	F=195; S=8556. Chief aquifer 195-240 ft. All sand and gravel
-8bb*	G. C. Englemann	1966	250	16	U(Ir)	7,500/18	4,930	185	1966	F=186; S=10167. Chief aquifer 240-250 ft. Warm water.
-9bc	--	--	--	16	U(Ir)	--	4,940	196.00	10- 7-71	
-10dd*	C. G. Perkins & Assoc.	1966	470	14	U(I)	--	--	327	1966	S=9356. Deepened from 394 ft. Chief aquifer 394-450 ft.
-13bb*	do.	1966	401	16	U(I)	--	--	329	1966	F=329; S=8913. Chief aquifer 329-401 ft.

*. Data from Alvin McLane, Desert Research Institute, 1972.

Table 13.--Selected well logs

[Asterisk indicates principal water-bearing zone, where known. Casing depth and perforated or screened intervals, in feet below land surface, are indicated in parentheses.]

Material	Thickness (feet)	Depth (feet)
RAILROAD VALLEY		
18/51½-23bc (cased to 370; perf. 335-370)		
Loam, sandy	5	5
Gravel and boulders, loose	50	55
Silt, sandy	280	335
Sand and gravel, water-bearing	35	370
18/53-28bda (cased to 465; perf. 430-460)		
Soil, sandy	10	10
Clay and gravel, cemented	410	420
Sand and gravel, water-bearing	45	465
1/53-32db (cased to 292; perf. 245-292)		
Soil	3	3
Gravel	15	18
Gravel and clay, cemented	227	245
Sand and gravel, water-bearing	47	292
2/53-23cbc (cased to 180; perf. 150-180)		
Sand and silt	100	100
Sand, water-bearing below 110 ft	80	180
4/55-19da (cased to 255; perf. 221-255)		
Topsoil	5	5
Gravel, cemented	25	30
Gravel, loose	5	35
Gravel, cemented	186	221
Gravel, loose, water-bearing	9	230
Clay, yellow	5	235
Gravel, loose, water-bearing	5	240
Clay, yellow	10	250
Gravel, loose, water-bearing	5	255
5/54-25dcb (cased to 100; perf. 50-100)		
Sand, water-bearing below 60 ft	100	100
5/55-15cd		
Soil, sandy clay	3	3
Gravel, coarse	3	6
Gravel with hard clay	64	70
5/55-28dbb (cased to 219; screen 57-172 and 190-215)		
Silt	5	5
Clay, hard	6	11
Gravel	7	18
Clay, white	7	25
Clay, brown	7	32
Gravel	9	41
Sandstone	4	45
Gravel, water-bearing	4	49
Clay	1	50
Sand, water-bearing	2	52
Clay	6	58
Gravel, water-bearing	5	63
Clay	2	65
Sand and gravel, water-bearing, with clay intervals at 75-77, 83-84, 90-95, and 106-109 ft	44	109
Sand and clay	3	112
Clay	2	114
Sand and gravel, water-bearing, with clay interval at 116-121 ft	12	126
Clay	9	135
Gravel, water-bearing	5	140
Clay	8	148
Sand and gravel, water-bearing	6	154
Clay	8	162
Gravel, water-bearing	10	172
Clay	19	191
Clay and gravel	2	193
Gravel, coarse, water-bearing*	26	219
5/55-32bbd (cased to 240; screen 80-160 and 180-240)		
Silt	3	3
Sand and fine gravel	9	12
Clay, white	8	20
Sand and gravel	17	37
Sandstone	3	40
Sand and gravel	20	60
Clay	10	70
Sand	2	72
Sand and gravel	5	77
Clay	3	80
Sand and gravel	7	87
Clay	3	90
Clay and gravel	6	96
Sand and gravel	10	106
Clay	3	109
Sand	3	112
Clay and gravel	8	120
Clay	5	125
Gravel	7	132
Clay	5	137
Clay and gravel	5	142
Clay	6	148
5/55-32bbd--Continued		
Sand and gravel	4	152
Gravel, coarse	7	159
Clay	27	186
Clay and gravel	14	200
Sand	1	201
Gravel	5	206
Clay	3	209
Sand	7	216
Clay	16	232
Gravel	7	239
Clay	1	240
5/55-33ddd (cased to 396; perf. 86-396)		
Topsoil, sandy loam	30	30
Gravel, cobble-sized	10	40
Clay and gravel	12	52
Sand and gravel	18	70
Clay and gravel with some sand	40	110
Sand and gravel with some clay	14	124
Sand and gravel, clean, water-bearing	12	136
Clay	4	140
Sand and gravel, coarse and cemented at 143 ft; water-bearing	9	149
Clay and gravel	51	200
Clay	5	205
Clay and gravel	13	218
Sand and gravel, water-bearing	1	219
Clay and gravel	23	242
Sand and gravel, coarse, clean, water-bearing	2	244
Clay and gravel	23	267
Sand and gravel, water-bearing	4	271
Clay and gravel	10	281
Sand and gravel, water-bearing	7	288
Clay	1	289
Sand and gravel, water-bearing	11	300
Clay, sand, and gravel	14	314
Sand and gravel, water-bearing	7	321
Clay, sand, and gravel	17	338
Sand and gravel, clean, water-bearing	5	343
Clay and gravel	15	358
Sand and gravel, clean, loose, water-bearing	4	362
Clay and gravel	5	367
Sand and gravel, water-bearing	4	371
Clay	4	375
Sand and gravel, fine, water-bearing	4	379
Clay	2	381
Sand and gravel, clean, coarse, water-bearing	3	384
Clay and gravel	4	388
Sand and gravel, clean, water-bearing*	6	394
Clay, solid	2	396
5/55-36dad2 (cased to 179; perf. 60-179)		
Topsoil, clay and gravel	16	16
Clay	4	20
Clay and gravel	10	30
Clay, gravel, and sand	10	40
Sand and gravel	10	50
Gravel, cobble-sized, water-bearing	10	60
Clay	10	70
Clay with some gravel	9	79
Gravel, some cobble-sized; water-bearing	5	84
Clay	2	86
Gravel, some cobble-sized; water-bearing	3	89
Clay	4	93
Gravel, cobble-sized, water-bearing	7	100
Clay	13	113
Clay and gravel	1	114
Gravel, fine, water-bearing	2	116
Clay and gravel	5	121
Gravel, coarse (cobblestone), water-bearing*	23	144
Clay and gravel	3	147
Sand and cobble-sized gravel, water-bearing	8	155
Gravel, cemented	13	168
Sand and gravel, cemented	11	179
6/56-27acb (cased to 98; perf. 50-98)		
Topsoil	3	3
Clay	17	20
Sand and clay	14	34
Clay, sand, and gravel	19	53
Sand and gravel	19	72
Sand and clay	12	84
Sand and gravel	14	98
6/57-6dda (cased to 150; perf. 130-150)		
Clay and gravel	52	52
Sand	3	55
Clay and gravel	25	80
6/57-6ddd--Continued		
Sand	16	96
Clay	28	124
Sand and small gravel, water-bearing	21	145
Clay	5	150
7/55-28ca (composite log from 46-ft water well and adjacent oil expl. hole; description of material below 108 ft based on ditch samples)		
Clay	5	5
Sand and gravel, water-bearing	41	46
No record	62	108
Sand, medium to coarse, multicolored, 65 to 50% of total; shale, gray-green, calcareous, silty, 20-45%; siltstone and volcanic pebbles, 15-5%	60	168
"Limestone," silty to medium sandy, massive, soft to hard, white to cream, argillaceous, 50%; volcanic pebbles, dark to greenish gray, 30%; sand and siltstone, 20%	30	198
"Limestone" as above, 75-80%; volcanic pebbles and siltstone, 20%	60	258
"Limestone" as above, grading in part to multicolored, fine to medium, calcareous sandstone, 95%; misc., 5%	60	318
"Limestone" as above, 65-80%; shale as above, 10-20%; siltstone, sand, and misc., 25-5%	90	408
No record	12	420
"Limestone" as above, 90-100%; shale as above, 10-0%	100	520
"Limestone" as above, 25%; soft, massive, silty to sandy, tan, calcareous shale, 75%	10	530
Shale as above	30	560
Gravel, medium to pebbly, multicolored, loosely consolidated with tan shale matrix	340	900
Gravel as above, but unconsolidated	50	950
Volcanic rock (tuff)	360	1,310
Limestone and dolomite (Paleozoic age)	401	1,711
7/56-2daa (cased to 260; perf. 180-260)		
Clay, light blue-gray, with trace of black carbonaceous(?) material	285	285
Adjacent oil-exploration hole 7/56-2dab penetrated valley fill to 6,510 ft, volcanics from 6,510 to 10,155 ft, and Paleozoic rocks to total depth (10,183 ft)		
7/56-10cb (cased to 425; perforated interval unknown)		
Clay, white, soft, sticky	23	23
Clay, black, soft, sticky	387	410
Clay, green, soft, sticky, yields small amount of water (water level had risen to 40 ft at start of bailer test)	15	425
7/57-4ccc (oil-expl. hole; description based almost entirely on ditch samples)		
No record	85	85
Claystone, light gray-green, calcareous, sandy (5-10%), with pebbles	150	235
Siltstone, gray, clayey, very sandy (10-20%), with occasional pebbles	30	265
Claystone as above, but very sandy (10-20%), with 10±% pebbles in all but top 30 ft	120	385
Claystone as above, 75%; ash, clear to gray, silty sandsize very porous, 25%	30	415
Mudstone, light to medium brown, silty and sandy, tuffaceous, very calcareous and porous, with interbedded ash(?)	60	475
Ash as above but white to green, 60%; mudstone as above, 40%	30	505
Siltstone, light gray and light green, sandy, very argillaceous and clayey, with occasional pebbles, 50%; ash as above, 25%; claystone, light green-brown, sandy, 25%	30	535
Claystone, light green, in part silty, 45%; mudstone, light to medium brown, silty, 35%; ash as above, but light brown, 20%; tufa, light to medium brown, 5%	60	595
Claystone, light gray-green to light brown, silty and sandy, very calcareous, with occasional rounded pebbles in upper part	90	685

Continued

Table 13.--Selected well logs--Continued

Material	Thickness (feet)	Depth (feet)
7/57-6acc--Continued		
No record	115	800
Claystone, gray-green with dark layers, very calcareous, slightly silty	120	920
Claystone as above, 60%; ash, light green to white, moderately to non-calcareous, 40%	60	980
Claystone, siltstone, mudstone, and some ash, similar to those described above	1,010	1,990
Basalt flow, altered, reddish purple to purple-black, very amygdaloidal	30	2,020
Mudstone with a little claystone in upper 70 ft; similar to those described above	940	2,960
Sand, fine to medium, angular to subangular, 50%; mudstone, tan to light brown, silty to sandy, calcareous, soft, sticky, 40%; conglomerate, coarse sand to pebble, mostly carbonates, 10%	150	3,110
Sand, fine to very coarse, angular to subrounded, 80%; mudstone as above, 20%	30	3,140
Siltstone, light brown, very calcareous and argillaceous, with sandy to pebbly zones	180	3,320
Siltstone, tan to light brown, calcareous, argillaceous, with sandy stringers, 25-60%; dolomite and limestone, tan, brown, gray, and white, 13-45% (percentage generally increases with depth); chert, clear, light red, and brown, 10-22%; volcanic particles and quartz grains, 28-10% (generally decreases with depth)	925	4,245
Siltstone as above, 10-40%; dolomite and limestone as above with some black, 55-70%; chert as above, and multicolored quartzite, 5-10%; volcanic particles, <5%	225	4,470
Siltstone as above, 40%; dolomite (dominant) and limestone as above, 45%; chert as above 15%	15	4,435
Siltstone as above, 5-30%; dolomite and limestone as above, 50-75%; chert and quartzite as above 10-25%; volcanic particles and quartz grains, <10%	583	5,018
Fanglomerate, gray-green (core no. 1). Material between 3,320 and 5,018 ft probably similar in character, but described from ditch samples	15	5,033
Bedrock dominated by limestone, dolomite, and shale (Schilling and Garside, 1968, p. 16)	2,452	7,485
7/57-4dbb (cased to 60; perf. 30-60)		
Clay, brown	5	5
Mud, blue, water-bearing at 30 ft.	45	50
Sand, water-bearing	10	60
7/57-5caa (cased to 85; perf. 50-85)		
Clay	5	5
Mud, blue	45	50
Sand, water-bearing	10	60
Mud, blue	25	85
7/57-17ba (uncased; "no water")		
Clay, brown	3	3
Clay, blue	197	200
Sand	2	202
Clay, blue	108	310
7/57-21aa? (cased to 150; perf. 130-150)		
Clay	9	9
Gravel, water-bearing	41	50
Sand, water-bearing	5	55
Sand and clay	50	105
Sand, water-bearing	10	115
Sand and clay	25	140
Sand, water-bearing	10	150
8/56-3dbb (oil-expl. hole; description based almost entirely on ditch samples)		
Sand, lithic and mineral grains, dominantly gray, tan, brown, and green; subangular to subrounded, medium to coarse and granule size, fairly well sorted	42	42
Clay, tan to greenish tan and gray-green, calcareous, in part sandy	398	440
Sand as above, but dominantly gray, gray-blue, purple, and red	20	460
Clay as above, but light gray-green	100	560
8/56-3dbb--Continued		
Sand as above	20	580
Clay as above, but greenish gray and greenish blue above 700 ft, light brown below	150	730
Clay, light tan, in part silty, 90%; volcanic fragments, multicolored, 8%; quartz grains, clear, fractured, 2%	10	740
Clay as above	40	780
Clay, light brown to grayish brown, slightly bentonitic, soft, 90%; volcanic fragments and quartz grains as above, 7 and 3%	15	795
Clay as above, slightly firmer below 855 ft	210	1,005
Clay as above, 50%; volcanic fragments and quartz grains as above, 45 and 5%	15	1,020
Clay with volcanic fragments	15	1,035
Volcanic fragments as above, 75%; clay and quartz as above, 20 and 5%	15	1,050
Clay with volcanic fragments	60	1,110
Volcanic fragments as above, 60-75%; clay as above, with some quartz above 1,125 and below 1,140 ft, 25-40%	45	1,155
Volcanic material, multicolored, subangular to angular, with quartz grains in places	1,045	2,200
Volcanic material as above, with bright, chalky, red, sharp-edged tuff, 60%; clay, light brown, soft, bentonitic, and minor quartz, 40%	40	2,240
Volcanic material as above, 60-100%, mostly greater than 80%; clay as above, 0-40%; quartz as above, 0-5%. Small amount of limestone (5% or less) in a few intervals. Core, 2,674-2,655 ft, conglomerate. Clasts, 50-60%: multicolored volcanics, 90%; tan limestone, 10%. Matrix, 40-50%: calcareous, tannish brown mudstone	1,610	3,850
Volcanic material as above, 80%; limestone, light tan, pink, and white, 15%; quartz as above, 5%. Core, 3,956-3,967 ft, conglomerate. Clasts, 50%: multicolored, angular to rounded, poorly sorted, well cemented, slightly calcareous volcanic detritus, 75-80% (remainder presumably limestone). Matrix, 50%: slightly calcareous clay, silt, and fine sand with an impermeable appearance	230	4,080
Volcanic material as above, 35-70%; dolomite and limestone fragments, angular to subangular, 20-55%; clay as above, 0-15% except 40% in interval 4,180-4,200 ft; quartz as above, 5-10%	325	4,405
Tentative top of volcanics in place at 4,405 ft. Volcanic rocks (mostly pyroclastic tuffs) from 4,405 ft to total depth	2,919	7,324
8/56-26bad (uncased auger hole)		
Crust, whitish, dry salt and clay	0.06	0.06
Clay and fine sand, tan, slightly moist	0.44	0.5
Clay, light tan; breaks conchoidally and is moist but not plastic above 2.0 ft, very plastic but not runny below 2.0 ft	4.0	4.5
Clay, black, very plastic but not runny, sulfide odor; somewhat less plastic below 6.5 ft	3.0	7.5
Same as above, but with small amount of fine sand; water-bearing	0.5	8.0
8/57-14ac (cased to 185; perf. at 20 and 160-180)		
Clay	6	6
Gravel, loose, water-bearing	8	14
Clay	16	30
Gravel, loose, water-bearing	8	38
Clay	12	50
Gravel, loose, water-bearing	10	60
Gravel, cemented	110	170
Gravel, loose, water-bearing*	10	180
Clay	5	185
8/57-22cdc (cased to 40; perf. 10-40)		
Sand, 50% of total, coarse to fine with occasional pebbles; clay, 50%, white, sticky, slightly calcareous	20	20
Sand and clay, 40 and 60%, same as above; chief aquifer from 19 to 22 ft	20	40
8/57-22cdc--Continued		
Sand, 90%, medium-grained quartz and limestone; shale, 10%, white, slightly calcareous	20	60
8/59-3? (cased to 100; perf. 50-95)		
"Wash" (surface sediment?)	10	10
Limestone, broken	35	45
Limestone, gray, water-bearing at 50 ft	15	60
"Fault" (gouge?)	10	70
Gravel	10	80
Quicksand, water-bearing*	20	100
9/57-1abb (cased to 200; perf. 144-196)		
Soil	3	3
Sand and ½-in. to 6-in. gravel	31	34
Sand, moist	4	38
Clay, sandy	34	72
Sand and gravel	6	78
Clay, soft, sandy, with gravel streaks	24	102
"Shell," hard, and large gravel	6	108
Clay, soft, and gravel	8	116
Gravel, ½-in. to 4-in.	4	120
Clay, sandy, and hard streaks	22	142
Gravel, pea to 6-in., "very good," water-bearing	58	200
9/57-6dab (cased to 141; perf. 129-141)		
Topsoil	4	4
Soil and clay, tight	6	10
Clay, sandy	4	14
Clay, soft, water-soaked	9	23
Clay, darker, denser	8	31
Sand and clay	2	33
Gravel, fine to coarse, water-bearing?	10	43
Sand, medium to fine, water-bearing?	24	67
Clay, brown, tight	34	101
Sand	2	103
Clay, white	1	104
Sand	2	106
Clay	3	109
Gravel and sand, semi-cemented	9	118
Clay, brown, tight	6	124
Gravel and sand, semi-cemented, water-bearing?	17	141
9/57-35bad2 (cased to 200; presumably open-end; perf. 40-80)		
Sand, silt, and gravel, 50% of total, angular to subrounded, varicolored; siltstone, 25%, soft, very calcareous; rock and pebbles, 25% of total	200	200
9/57-35bad4 (oil discovery hole; description based almost entirely on ditch samples)		
See log of adjacent well -35bad2	130	130
Sand, silt, and gravel, multicolored, angular to subrounded, with abundant quartz crystals, 50%; clay, light gray to buff, silty to sandy, very calcareous, 50%	630	760
Siltstone, light gray to buff, soft, sandy in places, calcareous, with abundant quartz crystals and some chert	220	980
Pebbles, multicolored, predominantly very coarse, with some quartz crystals; appears to be permeable and water-bearing	20	1,000
Siltstone as above, with 30% gray to buff, soft, flaky, in part silty to sandy, calcareous clay in interval 1,760-2,000 ft	2,110	3,110
Siltstone as above, but becoming harder, 50%; sand and pebbles, unconsolidated with abundant quartz crystals, 50%	50	3,160
Sand and pebbles as above	40	3,200
Siltstone as above, very sandy in places	40	3,240
Limestone, light to dark brown with calcite veins and crystals common	30	3,270
Limestone as above, 50%; dolomite, yellow, slightly limey, 50%	100	3,370
Dolomite, light to dark brown, very hard, limey in part, with calcite veins and crystals	100	3,470
Dolomite as above, 50%; shale, buff, silty to very sandy, very calcareous, moderately soft, with abundant quartz crystals, 50%	30	3,500
Shale as above, very sandy to pebbly in places, red-orange to light gray in interval 4,040-4,150 ft	910	4,410
Shale as above, 50%; sandstone, yellow, fine to coarse gravel, poorly sorted, calcareous, pebbly, 50%	10	4,420

Continued

Table 13.--Selected well logs--Continued

Material	Thickness (feet)	Depth (feet)
9/57-35bad4--Continued		
Shale as above, very sandy in places, with pebbles and gravel throughout; black spots of carbonaceous material common	290	4,710
Mudstone, buff to light gray, very calcareous, very hard and brittle in places, with abundant silt- to cobble-sized chips of limestone, dolomite, and chert; quartz crystals abundant (description based in part on cores from intervals 4,710-4,768 and 6,000-6,013 ft)	1,740	6,450
Pyroclastic volcanic rocks (Oligocene age?)	855	7,305
Limestone, shale, and dolomite (Sheep Pass Fm. of Eocene age)	480	7,785
Limestone, shale, and sandstone (Paleozoic age)	2,545	10,330
Quartz monzonite	28	10,358
10/57-12dda (cased to 401; perf. 140-220 and 241-401)		
Topsoil	2	2
Gravel and boulders	48	50
Clay and gravel	35	85
Gravel, cemented	135	220
Clay and gravel	9	229
Gravel, pea-size	8	237
Gravel, cemented	2	239
Gravel, pea-size	7	246
Gravel, tight	27	273
Clay and gravel	15	288
Gravel	14	302
Clay and gravel	17	319
Sand, cemented	9	328
Clay, sandy	5	333
Gravel, cemented	3	336
Gravel	6	342
Sand, cemented	3	345
Gravel, pea-size	3	348
Gravel, cemented	4	352
Conglomerate	32	384
Sand, cemented	5	389
Clay and gravel	4	393
Gravel	5	398
Clay and gravel	3	401
10/57-15aaa (cased to 200; perf. 105-200)		
Soil	3	3
Clay and gravel	47	50
Clay	55	105
Gravel, water-bearing	10	115
Clay	85	200
10/57-25abc (oil-exploration hole)		
Sand, gravel, and clay (Quaternary age)	1,420	1,420
Sand, gravel, and clay (Tertiary age)	1,995	3,415
Clay with streaks of sand (Tertiary age)	905	4,320
Volcanic rock, rhyolitic	720	5,040
Limestone and dolomite (Paleozoic age?)	516	5,556
10/57-27aaa (cased to 200; perf. 85-200)		
Surface material	15	15
Gravel	13	28
Clay, sandy	57	85
Sand and gravel, water-bearing	7	92
Clay, sandy	6	98
Sand and gravel	8	106
Clay, sandy	24	130
Sand and gravel, water-bearing*	12	142
Clay, sandy	26	168
Sand and gravel, water-bearing	4	172
Clay, sandy	28	200
10/59-16		
Gravel and boulders	60	60
Clay, blue, sticky	20	80
Boulders, limestone	5	85
Limestone	11	96
11/56-2adc (cased to 160; perf. 80-152)		
Soil, fine	1	1
Sand, gravel, and a few boulders	27	28
Lava, lava boulders, and fractured lava; minor amount of water	33	61
Lava, broken and fractured, water-bearing	5	66
Lava, solid	74	140
Lava, broken and fractured, water-bearing*	9	149
Lava, solid	21	170
Lava, fractured; minor amount of water	2	172
Lava, solid	78	250
12/55-25cd (cased to 289; perf. 240-289)		
Soil	3	3
Sand and gravel	117	120
Sand and gravel, cemented	120	240
Sand and gravel, water-bearing*	5	245
Sand and gravel, cemented	35	280
Sand and gravel, water-bearing	9	289
12/56-34cba (cased to 200; perf. 40-200)		
Surface material	3	3
Clay	24	27
Sand	7	34
Clay and boulders	16	50
Sand and gravel	37	87
Clay and boulders	31	118
Gravel, sand, and boulders*	42	160
Clay and boulders	13	173
Boulders	29	202
14/55-12bdb		
Gravel, coarse	87	87
Sand and gravel	255	342
Sand, fine	58	400
15/57-32ba2 (cased to 280; perf. 180-280)		
Surface material	2	2
Gravel, cemented	40	42
Clay	3	45
Gravel, cemented	58	103
Gravel with streaks of clay	39	142
Gravel, cemented	38	180
Gravel, water-bearing	6	186
Clay with gravel	38	224
Gravel and sand, water-bearing	5	229
Clay with gravel	44	273
Gravel and sand	3	276
Clay with gravel	4	280
PENOYER VALLEY		
2S/56-6ad (cased to 120; perf. 90-120)		
Sand	15	15
Sand in clay, water-bearing	70	85
Sand in gravel, water-bearing	35	120
3S/54-24ac		
Silt, sandy	2	2
Hardpan and sand	88	90
Gravel and sand, water-bearing	23	113
Clay and gravel, water-bearing	2	115
Gravel and sand, water-bearing	10	125
Sand in gravel, water-bearing	202	327
3S/54-25b2 (cased to 435; perf. 237-435)		
Old well	238	238
Sand and gravel, water-bearing	92	330
Sand and gravel, cemented, water-bearing	105	435

Table 14.--Water-level measurements in observation wells 1/53-7adc and 11/57-9cd

1/53-7adc		11/57-9cd			
Date	Water level (feet below land-surface datum)	Date	Water level (feet below land-surface datum)	Date	Water level (feet below land-surface datum)
2-20-68	77.78	2-13-48	175.2	9-18-53	174.51
3-20-69	78.81	4-25-48	174.94	9-10-54	173.79
2- 3-70	76.66	9-16-49	177.61	8-30-56	172.93
2- 9-71	76.48	3-27-50	a 174.40	10-25-57	172.32
10- 8-71	76.57	9-15-50	a 174.03	6-18-68	b 172.93
2-15-72	76.77	3-13-51	a 174.62	7-19-69	b 172.74
3-30-72	77.95	9-11-51	174.04	10- 5-71	171.77
		3-26-52	a 174.32	4- 1-72	171.67
		9- 9-52	173.89		

a. Pumped recently (windmill).

b. Data from Alvin McLane, Desert Research Institute, 1972.

Table 15.--Spring data[1/]

Location	Name	Approximate land-surface altitude (feet)	Date	Flow (gpm)[2/]	Temperature °F	Temperature °C	Chloride (mg/l)	Hardness as $CaCO_3$ (mg/l)	Specific conductance (micromhos)
			RAILROAD VALLEY						
2S/51-17a	Summer	6,700	--	3	--	--	--	--	--
-21d	Cedar	6,540	8- 1-67	2.5	77	25.0	23	180	533
1/52-22cb	Pyramid	5,820	8- 3-67	0.2	68	20.0	9.9	128	415
2/52-7cd	--	6,400	8- 3-67	--	58	14.5	11	163	427
3/55-27db	--	7,000±	11- 8-70	5	45	7.0	--	--	277
6/54-11aa	Storm	4,805	10- 7-71	5	98	36.5	17	320	1,200
-11dc	Coyote Hole	4,820	8- 7-67	2	113	45.0	9.8	356	1,070
-23bd	Abel	4,800	9-12-68	25	115	46.0	15	358	1,100
6/56-27acb	Crows Nest	4,755	8- 7-67	--	56	13.5	3.3	201	391
6/57-1b	--	6,000±	11- 7-70	1.0m	53	11.5	6	260	528
-5baa	Willow	4,750	2- 7-34	30m	60	15.5	--	--	--
7/55-16db	Chimney Hat	4,810	2- 7-34 8- 7-67	95 20	-- 140	-- 60.0	-- 10	-- 211	-- 640
7/57-28acb	Bullwhacker	4,760	2- 7-34	10	59	15.0	--	--	--
-28cbd	Thorn	4,750	10-13-71	50-100	--	--	14	275	686
8/55-14bcb	Hay Corral[3/]	4,770	3-30-72	450m	--	--	--	--	--
-15aaa	North[3/]	4,805	11- 2-65	(a)	95	35.0	12	260	694
-15acb	Big[3/]	4,820	6-21-67	(a)	100	37.5	10	252	694
-15add	Reynolds[3/]	4,770	10- 6-71	(a)	97	36.0	--	--	--
8/57-11ddb	Blue Eagle[3/]	4,765	2-13-48 10- 6-71	2,260m b 1,860m	-- 82	-- 28.0	-- 9	-- 190	-- 584
-14ac	Kate	4,755	1-24-35	14	73	23.0	--	--	--
-27dac	Butterfield	4,750	1-24-35	230	64	18.0	--	--	--
10/55-9a	Ike	6,600	11- 6-70	1.2m	54	12.0	20	130	411
10/58-9bcc	--	5,250	10-12-71	200	55	13.0	10	380	799
11/56-30daa	Bradshaw	6,020	--	c 1-5	--	--	--	--	--
-31bca	Indian	6,180	8- 7-67	1	64	18.0	23	117	368
-31ccd	Leoman	6,300	--	c 1-5	--	--	--	--	--
11/58-15aca	Snow (Crystal)	6,380	--	c 1-5	--	--	--	--	--
-32bbc	Pastroni	5,360	10-12-71	300	55	13.0	11	180	432
12/55-16c	McClure	6,310	--	c 1	--	--	--	--	--
12/56-5ac	Little Warm	5,590	10- 6-71	b 200m	60	15.5	10	200	704
-5cbd	--	5,460	10- 5-71	50	56	13.5	8	190	551
-10ccd	--	5,580	10-12-71	1	--	--	18	60	462
-18dda	Old Collins	5,440	--	c several	--	--	--	--	--
13/55-6d	Big Louie	6,270	11- 6-70	1.0m	54	12.0	18	200	487
-20b	Young Florio	6,240	11- 6-70	0.3m	55	13.0	--	--	344
13/56-32bac	Big Warm	5,605	4-16-63	(a)	90	32.0	7	260	586
14/56-14ddc	Big Bull	5,820	11- 6-70	d 400m	--	--	6	160	365
-25bdc	Bull Creek	5,790	--	e 225m	54	12.0	--	--	--
14/57-22aaa	Birch	6,250	11- 5-70	5-10	46	8.0	24	240	574
15/55-29c	Nevada Governors	6,350	4- 2-72	Dry	--	--	--	--	--
15/57-33cbd	Green	6,080	11- 5-70	f 100+	63	17.0	--	--	488
			PENOYER VALLEY						
2S/55-26dda	Sand	4,805	10- 5-71	0.2m	86	30.0	5	180	609

Footnotes to table 15:

1. Data from U.S. Geological Survey files except as indicated. For most springs with chemical-quality information listed, additional data are in table 17.

2. Measured flow indicated by "m." All others are estimated.

3. Flow quantities listed by Eakin and others (1951 p. 148) for 2-7-34 may be estimates rather than measurements on the basis of several field notes.

a. See table 16.

b. Flow measured 3-30-72.

c. Data from R. H. LeDosquet (U.S. Bur. Land Management, written commun., 1971).

d. Earlier undated estimates indicate that flow may exceed 400 gpm at times: Flow has been several cubic feet per second, according to R. H. LeDosquet (U.S. Bur. Land Management, written commun., 1971), and about 5 cfs, according to C. T. Snyder (U.S. Geol. Survey, written commun., 1971).

e. Data from Mifflin (1968, app. table 4).

f. Earlier undated estimates indicate that flow may appreciably exceed 100 gpm at times: Flow has been greater than 1 cfs, according to LeDosquet; about 2 cfs, according to Snyder (see footnote d); and about 1½ cfs (in about 1948, according to notes recorded by G. B. Maxey, U.S. Geol. Survey).

Table 16.--Discharge measurements for Big Warm Spring near Duckwater and three springs at Lockes, 1967-72[a]

Date	Discharge (cubic feet per second) North Spring (8/55-15aaa)	Big Spring (8/55-15acb)	Reynolds Springs (8/55-15add)	Big Warm Spring (13/56-32bac)
8- 4-67 to 6-11-68	(b)	(b)	(b)	(b)
7- 9-68	0.37	1.02	0.60	12.9
8- 1-68	.39	1.04	.64	13.8
8-28-68	.45	.86	.50	13.2
9-26-68	.31	.81	.58	12.4
10-28-68	.49	.83	.74	14.1
11-22-68	.48	.89	.96	--
12-19-68	.42	1.02	.56	--
1-15-69	.41	.84	.64	--
3- 5-69	.44	1.08	.68	--
4- 2-69	.40	1.12	.79	--
4-29-69	.33	1.20	.71	--
5-29-69	.39	1.07	.73	12.6
6-25-69	.37	.96	.70	14.3
7-30-69	.32	1.35	.78	13.4
10- 7-69	.45	1.07	.81	12.3
11- 8-69	.36	.97	.75	12.9
12- 3-69	.56	.97	.75	--
1- 6-70	.54	1.07	.64	--
2- 9-70	.43	1.02	.67	--
3- 4-70	.34	1.06	.56	--
4-15-70	.32	--	.58	12.7
5- 5-70	.32	--	.63	12.7
6-30-70	.36	1.02	.67	13.3
8-21-70	.31	1.42	.96	--
11-23-70	.34	1.21	1.31	11.9
1-23-71	.28	1.07	.83	--
3- 2-71	.17	1.27	1.13	13.6
4-19-71	.43	1.14	.63	13.8
6-22-71	.31	1.04	.71	12.4
10- 5-71	.32	.80	1.11	12.7
2- 3-72	.38	1.10	.75	11.7
1967-72				
Maximum	.56	1.42	1.31	14.3
Minimum	.17	.80	.50	c 11.7
Average	.38	1.06	.74	c 13.0

a. Data provided by D. D. Gonzalez (U.S. Geol. Survey, written commun., 1972).

b. Data published by U.S. Geological Survey (1969, p. 161).

c. Measurements of 1-17-68 and 4-11-68 not used, because entire flow probably was not measured.

Table 17.--Chemical analysis of well, spring, and stream waters

PART A

Location	Source (with well depth or streamflow where appropriate)	Date sampled	Temperature °F	Temperature °C	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids[3]	Hardness as $CaCO_3$	Specific conductance (micromhos per cm at 25°C)	pH[4]	Salinity hazard	SAR	Sodium hazard	RSC
					Milligrams per liter (upper number) and milliequivalents per liter (lower number)[1]														Factors affecting suitability for irrigation[2]			
									RAILROAD VALLEY													
28/51-21d	Cedar Spring	a/ 8- 1-67	77	25.0	62 3.09	5.9 0.49	47 2.04	2.5 0.06	240 3.93	0 0.00	48 1.00	23 0.65	0.8 0.04	0.1 0.00	346	180	533	7.7	L	1.5	L	S
1S/53-28bda	Deep well (465 ft)	3-29-72	70	21.0	14 0.70	1 0.10	b/ 65 2.81		138 2.26	0 0.00	46 0.96	14 0.39	--	--	--	40	385	8.1	L	4.4	L	M
1/52-22cb	Pyramid Spring	a/ 8- 3-67	68	20.0	43 2.15	4.9 0.40	40 1.74	0.8 0.02	204 3.34	0 0.00	31 0.65	9.9 0.28	--	3.4 0.05	262	128	415	7.9F	L	1.5	L	S
1/53-3dac	East Side well (120 ft)	10- 8-71	--	--	45 2.25	4 0.35	b/130 5.61		273 4.47	0 0.00	97 2.02	61 1.72	--	--	--	130	831	8.1	M	5.0	L	M
-7adc	Fred's well (136 ft)	a/ 9-13-68	63	17.0	0.7 0.03	0.0 0.00	979 42.59	9.6 0.25	369 6.05	490 16.33	460 9.58	c/380 10.72	5.6 0.45	2.5 0.04	2,610	2	4,060	10.2F	V	350	V	U
-27bba	Last Stand well (200 ft)	3-29-72	69	20.5	11 0.55	0 0.00	b/150 6.46		283 4.64	0 0.00	87 1.81	20 0.56	--	--	--	27	722	8.2	L	12	M	U
-31dcc	Pyramid well (272 ft)	a/ 9-14-68	63	17.0	17 0.85	1.8 0.15	39 1.70	5.0 0.13	148 2.43	0 0.00	7.0 0.15	7.2 0.20	1.4 0.07	0.3 0.00	207	50	273	7.8	L	2.4	L	S
2/52-7cd	Spring	a/ 8- 3-67	58	14.5	62 3.09	1.8 0.15	26 1.13	0.6 0.02	216 3.54	0 0.00	27 0.56	11 0.31	--	5.8 0.09	275	163	427	7.5F	L	.9	L	S
2/53-23cbc	Sunrise well (180 ft)	10- 8-71	66	19.0	31 1.55	3 0.21	b/ 89 3.85		219 3.59	0 0.00	71 1.48	19 0.54	--	--	--	88	556	8.3	L	4.1	L	M
3/53-35bac	Ed's well	a/ 9-13-68	57	14.0	6.0 0.30	0.8 0.07	115 5.00	8.2 0.21	207 3.39	0 0.00	59 1.23	c/ 20 0.56	12 0.63	0.3 0.00	410	19	565	7.4F	L	12	M	U
3/54-5bc	Coat Ranch well (325 ft)	d/ 3-30-72	--	--	6 0.30	0 0.02	b/160 6.81		281 4.61	7 0.23	80 1.67	22 0.62	--	--	--	16	787	8.6	M	17	H	U
4/55-19da	Well (255 ft)	10- 9-71	--	--	27 1.35	3 0.21	b/ 28 1.23		128 2.10	0 0.00	21 0.44	9 0.25	--	--	--	78	289	8.0	L	1.4	L	S
-25d	Big Creek (0.35 cfs)	11- 8-70	49	9.5	62 3.09	18 1.51	b/ 21 0.91		242 3.97	0 0.00	62 1.29	9 0.25	--	--	--	230	508	--	L	0.6	L	S
5/55-32bbd	Well (240 ft)	10-13-71	61	16.0	44 2.20	5 0.40	b/ 35 1.51		133 2.18	0 0.00	52 1.08	30 0.85	--	--	--	130	426	8.0	L	1.3	L	S
-34cdd	Well (398 ft)	10-13-71	60	15.5	25 1.25	9 0.71	b/ 22 0.96		147 2.41	0 0.00	18 0.37	5 0.14	--	--	--	98	286	7.7	L	1.0	L	S
-36dad1	Well (105 ft)	d/10-13-71	50	10.0	44 2.20	22 1.80	b/ 18 0.80		242 3.97	0 0.00	28 0.58	9 0.25	--	--	--	200	454	8.0	L	0.6	L	S
5/56-35da	Hopper Creek (about 0.1 cfs)	11- 8-70	46	8.0	48 2.40	15 1.20	b/ 8 0.37		215 3.52	0 0.00	15 0.31	5 0.14	--	--	--	180	371	--	L	0.3	L	S
6/54-23bd	Abel Spring	a/ 9-12-68	115	46.0	100 4.99	26 2.14	120 5.22	22 0.56	673 11.03	0 0.00	51 1.06	15 0.42	2.7 0.14	0.2 0.00	696	358	1,100	7.5F	M	2.8	L	U
6/56-5ccc	Well (745 ft)	a/ 9-13-68	66	19.0	13 0.65	4.4 0.36	50 2.18	6.4 0.16	167 2.74	0 0.00	17 0.35	c/ 5 0.14	2.4 0.13	0.3 0.00	255	51	319	8.2F	L	3.1	L	M
-18dbd	Nyala well 2 (131 ft)	10-13-71	56	13.5	23 1.15	10 0.85	b/ 41 1.77		155 2.54	5 0.17	40 0.83	8 0.23	--	--	--	100	374	8.5	L	1.8	L	S
-24bdc	Troy Canyon creek diversion (0.3-0.4 cfs)	10-13-71	52	11.0	36 1.80	15 1.20	b/ 16 0.71		190 3.11	0 0.00	22 0.46	5 0.14	--	--	--	150	362	7.9	L	0.6	L	S
-27acb	Well (98 ft)	10- 6-71	56	13.5	40 2.00	22 1.80	b/ 9 0.39		237 3.88	0 0.00	11 0.23	3 0.08	--	--	--	190	402	8.2	L	0.3	L	S
6/57-1b	Spring	11- 7-70	53	11.5	73 3.64	19 1.56	b/ 18 0.79		300 4.92	0 0.00	43 0.90	6 0.17	--	--	--	260	528	--	L	0.5	L	S
7/55-16db	Chimney Hot Spring	a/ 8- 7-67	140	60.0	56 2.79	17 1.40	68 2.96	17 0.43	350 5.74	0 0.00	47 0.98	26 0.73	--	0.0 0.00	455	211	640	7.5F	L	2.0	L	M
-28ca	Well (1,711 ft) e,f/	10- 6-55	140	60.0	12 0.60	5 0.41	b/189 8.22		410 6.72	0 0.00	99 2.06	16 0.45	--	--	--	51	--	8.3	M	16	H	U
7/56-2dab	Well (9,928-10,123 ft) e g/	11-24-54	229	109.0	7 0.35	6 0.49	b/192 8.36		293 4.81	43 1.43	50 1.04	68 1.92	--	--	--	42	--	9.0	M	13	H	U
7/57-28cbd	Thorn Spring	10-13-71	--	--	57 2.84	33 2.75	b/ 35 1.52		378 6.20	0 0.00	25 0.52	14 0.39	--	--	--	280	686	7.8	L	0.9	L	S
8/55-15acb	Big Spring	a/ 6-21-67	100	37.5	66 3.29	21 1.73	52 2.26	10 0.26	376 6.16	0 0.00	59 1.23	10 0.28	1.2 0.06	0.0 0.00	431	257	694	7.5F	L	1.6	L	S
8/56-2dac	Big well (1,204 ft)	a/ 8- 7-67	68	20.0	12 0.60	9.6 0.79	63 2.74	10 0.26	208 3.41	0 0.00	10 0.21	25 0.71	c/0.9 0.05	0.2 0.00	321	70	419	7.8F	L	3.3	L	M
-3acb	Well (550 ft)	10-10-71	57	14.0	16 0.80	7 0.56	b/ 55 2.38		173 2.84	6 0.20	20 0.42	10 0.28	--	--	--	68	371	8.6	L	2.9	L	M
-26bad	Auger hole (8 ft)	d/10-11-71	--	--	6 0.30	1 0.10	b/1,400 58.78		527 8.64	30 1.00	76 1.58	1,700 47.96	--	--	--	20	6,680	9.0	V	130	V	U
8/57-7ca	Well (55 ft)	d/10-11-71	--	--	2 0.12	0 0.00	b/150 6.69		262 4.29	23 0.77	58 1.21	19 0.54	--	--	--	6	699	9.0	L	27	V	U
-11ddb	Blue Eagle Spring	10- 6-71	82	28.0	30 1.50	28 2.30	b/ 48 2.07		297 4.87	0 0.00	36 0.75	9 0.25	--	--	--	190	584	8.1	L	1.5	L	S
-22cdc	Well (43 ft)	d/10-11-71	--	--	25 1.25	33 2.75	b/ 37 1.61		303 4.97	0 0.00	16 0.33	11 0.31	--	--	--	200	590	8.3	L	1.1	L	S
-27aac	Well (5,318-5,474 ft) e g/	8-10-54	--	--	25 1.25	11 0.90	b/163 7.10		439 7.20	0 0.00	77 1.60	16 0.45	--	--	--	108	--	7.0	M	6.8	M	U
9/56-14bda	Trapp Spring well (101 ft)	d/10-10-71	--	--	47 2.35	25 2.05	b/ 46 1.99		262 4.29	7 0.23	68 1.42	16 0.45	--	--	--	220	611	8.5	L	1.3	L	S
9/57-6dab	Well (138 ft)	10-11-71	54	12.0	45 2.25	24 1.95	b/ 92 4.01		356 5.83	0 0.00	90 1.87	18 0.51	--	--	--	210	772	8.2	M	2.8	L	M
-20cab	Gravel Ridge well (219 ft)	a/ 8- 7-67	56	13.5	31 1.55	25 2.06	43 1.87	6.7 0.17	218 3.57	0 0.00	64 1.33	25 0.71	--	1.6 0.03	387	181	501	7.7F	L	3.4	L	S
-34add	Well (7,148-7,256 ft) h/	4- 1-72	Hot		680 33.93	0 0.04	b/11,000 483.92		51 0.84	0 0.00	1,800 37.48	17,000 479.57	--	--	--	1,700	50,100	7.2	U	120	V	S
-35adc	Well (79 ft)	10-12-71	--	--	44 2.20	22 1.80	b/ 49 2.13		223 3.65	0 0.00	30 0.62	66 1.86	--	--	--	200	616	8.3	L	1.5	L	S
-35bad3	Well (220 ft)	3-31-72	59	15.0	35 1.75	18 1.45	b/ 28 1.23		231 3.79	0 0.00	21 0.44	7 0.20	--	--	--	160	411	8.1	L	1.0	L	S
-35bad4	Well (6,430-6,730 ft) e h/	11-10-55	--	--	1,970 98.30	63 5.18	b/ 7,180 312.33		29 0.48	0 0.00	1,380 28.73	13,700 386.34	--	--	24,300	20,500	--	6.8	U	44	V	S

Table 17.--Chemical analysis of well, spring, and stream waters--Continued

Location	Source (with well depth or streamflow where appropriate)	Date sampled	Temperature °F	Temperature °C	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids[3]	Hardness as $CaCO_3$	Specific conductance (micromhos per cm at 25°C)	pH[4]	Salinity hazard	SAR	Sodium hazard	RSC
					Milligrams per liter (upper number) and milliequivalents per liter (lower number)[1]													Factors affecting suitability for irrigation[2]				
10/55-9ac	Ike Spring a/	9-12-68	59	15.0	46 2.30	2.5 0.21	34 1.48	2.0 0.05	177 2.90	0 0.00	26 0.54	18 0.51	0.3 0.02	8.7 0.14	270	126	405	7.7F	L	1.3	L	S
10/57-15add	Well (251 ft)	4-1-72	59	15.0	38 1.90	18 1.50	b/ 43 1.87		252 4.13	0 0.00	40 0.83	11 0.31	--	--	--	170	484	8.0	L	1.4	L	S
-32bbb	Well (348 ft) a/	8-7-67	61	16.0	36 1.80	15 1.23	31 1.35	3.9 0.10	193 3.16	0 0.00	38 0.79	15 0.42	--	4.2 0.07	266	152	429	7.7F	L	1.1	L	S
10/58-9bcc and cbb	Spring	10-12-71	55	13.0	84 4.19	41 3.40	b/ 32 1.39		489 8.01	0 0.00	33 0.69	10 0.28	--	--	--	380	799	8.0	M	0.7	L	S
11/56-31bca	Indian Spring a/	8-7-67	64	18.0	37 1.85	5.8 0.48	36 1.57	7.9 0.20	160 2.62	0 0.00	28 0.58	23 0.65	--	8.3 0.13	299	117	368	7.6F	L	1.5	L	S
11/58-32bbc	Pastroni Springs	10-12-71	55	13.0	36 1.80	22 1.80	b/ 20 0.88		230 3.77	0 0.00	19 0.40	11 0.31	--	--	--	180	432	7.9	L	0.7	L	S
11/59-5ba	Little Currant Creek (78 cfs)	4-20-69	43	6.0	45 2.25	10 0.83	b/ 11 0.49		194 3.18	0 0.00	12 0.25	5 0.14	--	--	--	154	330	8.2	L	0.4	L	S
	(0.29 cfs)	11-4-70	39	4.0	50 2.50	16 1.30	b/ 8 0.33		235 3.85	0 0.00	8 0.17	4 0.11	--	--	--	190	376	--	L	0.2	L	S
-15ba	Stream (0.75 cfs)	4-3-69	49	9.5	25 1.25	5 0.43	b/ 12 0.52		106 1.74	0 0.00	14 0.29	6 0.17	--	--	--	84	220	7.9	L	0.6	L	S
-16ba	Well (290 ft) i/	7-14-68	52	11.0	51 2.54	13 1.07	b/ 37 1.62		232 3.80	0 0.00	36 0.75	14 0.39	--	18 0.29	j/339	181	--	8.0	L	1.2	L	S
12/56-5ab	Little Warm Spring	10-6-71	--	--	39 1.95	25 2.05	b/ 83 3.60		368 6.03	0 0.00	62 1.29	10 0.28	--	--	--	200	704	8.0	L	2.5	L	M
-5cbd	Spring	10-5-71	56	13.5	31 1.55	27 2.25	b/ 43 1.89		272 4.46	0 0.00	48 1.00	8 0.23	--	--	--	190	551	8.0	L	1.4	L	S
-10ccd	Spring	10-12-71	--	--	22 1.10	1 0.10	b/ 74 3.23		196 3.21	0 0.00	34 0.71	18 0.51	--	--	--	60	462	8.3	L	4.2	L	M
12/57-9bab	Bull Creek well 2 (356 ft)	4-2-72	59	15.0	24 1.20	9 0.76	b/ 29 1.27		148 2.43	0 0.00	22 0.46	12 0.34	--	--	--	98	326	8.0	L	1.3	L	S
13/55-6d	Big Louis Spring a/	9-12-68	57	14.0	56 2.79	11 0.90	23 1.00	6.0 0.15	245 4.02	0 0.00	24 0.50	c/18 0.51	0.3 0.02	1.1 0.17	355	185	464	7.7F	L	0.7	L	S
13/56-32bac	Big Warm Spring a/	6-21-67	91	33.0	62 3.09	22 1.81	28 1.22	6.5 0.17	321 5.26	0 0.00	47 0.98	8.6 0.24	0.6 0.03	0.0 0.00	350	246	587	8.0	L	0.8	L	S
14/56-14ddc	Big Bull Spring	11-6-70	52	11.0	36 1.80	17 1.40	b/ 14 0.61		194 3.18	0 0.00	22 0.46	6 0.17	--	--	--	160	365	--	L	0.5	L	S
14/57-22aaa	Birch Spring	11-5-70	46	8.0	62 3.09	21 1.71	b/ 26 1.13		272 4.46	0 0.00	38 0.79	24 0.68	--	--	--	240	574	--	L	0.7	L	S
									PENOYER VALLEY													
2S/55-26dda	Sand Spring	10-5-71	86	30.0	36 1.80	22 1.80	b/ 67 2.91		357 5.85	0 0.00	25 0.52	5 0.14	--	--	--	180	609	8.0	L	2.2	L	M
3S/55-7ccc	Well	10-5-71	67	19.5	33 1.65	4 0.35	b/ 60 2.62		132 2.16	0 0.00	74 1.54	24 0.68	--	15 0.24	--	100	477	8.2	L	2.6	L	S
-23ded	Well d/	10-5-71	--	--	59 2.94	20 1.66	b/160 7.06		228 3.74	2 0.06	330 6.87	35 0.99	--	--	--	230	1,170	8.4	M	4.7	L	S
-29	Well (300 ft) a/	6-21-62	60	15.5	42 2.10	2.8 0.23	30 1.31	11 0.28	159 2.61	0 0.00	41 0.85	8.8 0.25	0.6 0.03	1.3 0.02	298	116	371	7.7	L	1.2	L	S
3S/56-17ded	Well	10-5-71	--	--	44 2.20	17 1.40	b/ 17 0.72		202 3.31	4 0.13	34 0.71	6 0.17	--	--	--	180	416	8.4	L	2.5	L	S

PART B

Location	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Orthophosphate (PO_4)	Boron (B)	Location	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Orthophosphate (PO_4)	Boron (B)
2S/51-21d	38	0.03	0.00	0.00	0.19	7/53-16db	51	0.04	0.00	0.00	0.40
3S/55-29	83	--	--	--	.0	8/55-15acb	26	.06	.00	.00	.40
1/52-22cb	20	.06	.04	.01	.12	8/56-2dac	88	.05	.00	.00	.28
1/53-7ada	93	.04	.00	5.3	--	9/57-20aab	83	.02	.00	.00	.16
-31dcc	55	.20	.01	.00	--	10/55-9ac	45	.00	.00	.00	--
2/52-7cd	34	.02	.01	.00	.12	10/57-32bbb	27	.00	.00	.00	.14
3/53-35bac	86	.04	.01	.00	--	11/56-31bca	73	.00	.00	.00	.27
6/54-23bd	27	.02	.00	.00	--	13/55-6d	95	.02	.00	.00	--
6/56-5acc	74	.02	.00	.00	.29	13/56-32bac	25	.06	.01	.00	.12

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. Where only one number is shown, it is milligrams per liter.

2. Salinity hazard is based on specific conductance (in micromhos) as follows: 0-750, low hazard (L; water suitable for almost all applications); 750-1,500, medium (M, can be detrimental to sensitive crops); 1,500-3,000, high (H; can be detrimental to many crops); 3,000-7,500, very high (V; should be used only for tolerant plants on permeable soils); >7,500, unsuitable (U). SAR (sodium adsorption ratio) provides an indication of what effect an irrigation water will have on soil-drainage characteristics. SAR is calculated as follows, using milliequivalents per liter: $SAR=Na/\sqrt{(Ca+Mg)/2}$. Where sodium plus potassium are computed by difference rather than analyzed for (footnote b), that value is used to compute SAR. Sodium hazard is based on an empirical relation between salinity hazard and sodium-adsorption ratio: low (L), medium (M), high (H), or very high (V). RSC (residual sodium carbonate): safe (S), marginal (M), or unsuitable (U). 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 National Technical Advisory Committee (1968, p. 143-177), and the U.S. Salinity Laboratory Staff (1954).

3. Computed sum (with bicarbonate multiplied by 0.492 to make result comparable with residue values).

4. Laboratory determinations, except for field measurements indicated by "F."

a. Detailed laboratory analysis; additional determinations are listed in part B of this table.
b. Sodium plus potassium, computed as the milliequivalent-per-liter difference between the determined negative and positive ions; expressed as sodium (the concentration of sodium generally is at least 5-10 times that of potassium). Computation assumes that concentrations of undetermined negative ions--especially nitrate--are small.
c. Estimated on basis of an additional analysis or analyses.
d. Sample bailed from unused well or from stock-water storage tank; may not represent chemical character of water yielded by well after appreciable pumping.
e. Analysis by Shell Oil Co. Temperature is maximum measured at time of logging.
f. Sample from 1,700 ft while flowing.
g. Collected during drill-stem test (depth of tested interval is indicated); sample is assumed to be mostly formation water rather than drilling fluid.
h. Production water; producing interval is indicated.
i. Analysis by Nevada State Health Division.
j. Residue on evaporation at 105°C.

Table 18.--Relation between English and metric units of measure

English unit	Metric unit	Multiplication factor to convert from English to metric quantity
Inches (in)	Millimeters (mm)	25.4
Feet (ft)	Meters (m)	0.305
Miles (mi)	Kilometers (km)	1.61
Acres	Square meters (m^2)	4050
Square miles (sq mi)	Square kilometers (km^2)	2.59
Gallons (gal)	Liters (l)	3.78
Acre-feet (acre-ft)	Cubic meters (m^3)	1230
Cubic feet per second (cfs)	Liters per second (l/s)	28.3
Do.	Cubic meters per second (m^3/s)	0.0283
Gallons per minute (gpm)	Liters per second (l/s)	0.0631

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Report No.	Valley or area
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11	Hualapai Flat*
12	Ralston and Stone Cabin
13	Cave*
14	Amargosa Desert, Mercury, Rock, Fortymile Canyon, Crater Flat, and Oasis*
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17	Duck Lake
18	Garden and Coal
19	Middle Reese and Antelope
20	Black Rock Desert, Granite Basin, High Rock Lake, Mud Meadow, and Summit Lake*
21	Pahranagat and Pahroc
22	Pueblo, Continental Lake, Virgin, and Gridley Lake
23	Dixie, Stingaree, Fairview, Pleasant, Eastgate, Jersey, and Cowkick
24	Lake*
25	Coyote Spring, Kane Springs, and Muddy River Springs*
26	Edwards Creek
27	Lower Meadow, Patterson, Spring (near Panaca), Rose, Panaca, Eagle, Clover and Dry
28	Smith Creek and Ione*
29	Grass (near Winnemucca)
30	Monitor, Antelope, Kobeh, and Stevens Basin*
31	Upper Reese*
32	Lovelock
33	Spring (near Ely)*
34	Snake, Hamlin, Antelope, Pleasant, and Ferguson Desert*
35	South Fork, Huntington, and Dixie Creek-Tenmile Creek
36	Eldorado, Piute, and Colorado River*
37	Grass (near Austin) and Carico Lake*
38	Hot Creek, Little Smoky, and Little Fish Lake*
39	Eagle (Ormsby County)*
40	Walker Lake and Rawhide Flats
41	Washoe*
42	Steptoe
43	Honey Lake, Warm Springs, Newcomb Lake, Cold Spring, Dry, Lemmon, Red Rock, Spanish Springs, Bedell Flat, Sun, and Antelope*
44	Smoke Creek Desert, San Emidio Desert, Pilgrim Flat, Painters Flat, Skedaddle Creek, Dry (near Sand Pass), and Sano*
45	Clayton, Stonewall Flat, Alkali Spring, Oriental Wash, Lida, and Grapevine Canyon
46	Mesquite, Ivanpah, Jean Lake, and Hidden
47	Thousand Springs and Grouse Creek*
48	Little Owyhee River, South Fork Owyhee River, Independence, Owyhee River, Bruneau River, Jarbidge River, Salmon Falls Creek and Goose Creek
49	Butte*
50	Lower Moapa, Black Mountains, Garnet, Hidden, California Wash, Gold Butte, and Greasewood

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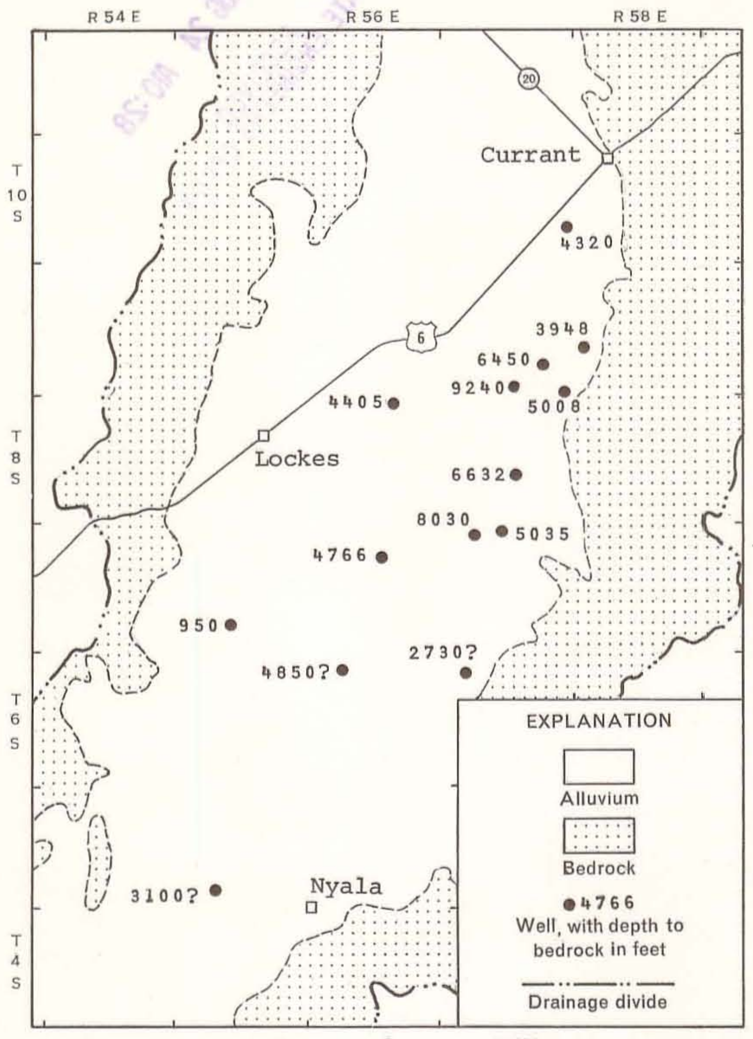
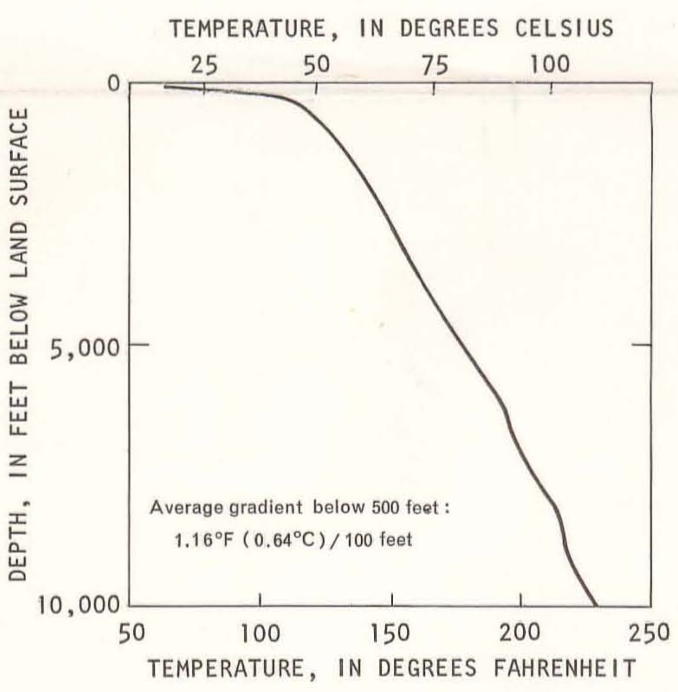
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES-RECONNAISSANCE REPORT 60

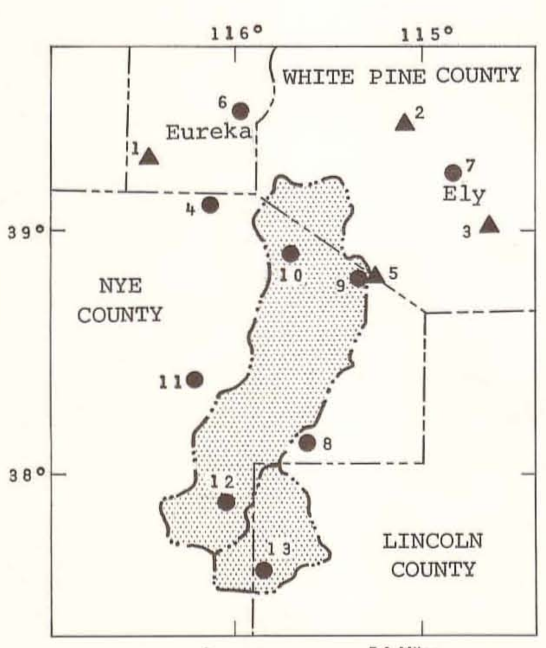
STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCE
DIVISION OF WATER RESOURCES



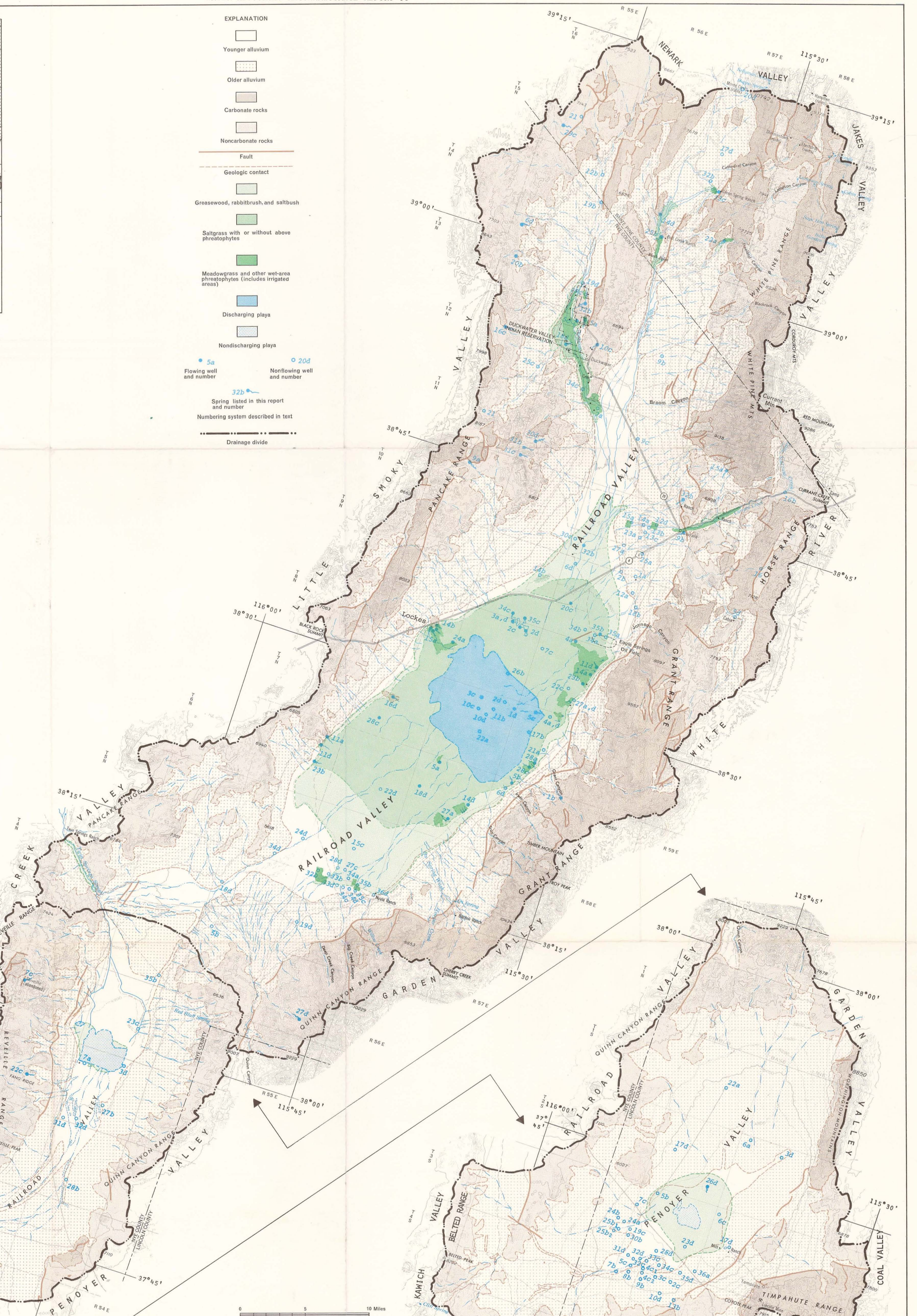
Depth to bedrock in oil exploration wells. Data from Schilling and Garside (1968) or, where followed by question mark, from interpretation of induction-electric log.



Temperature log for well 7/56-2dab (Shell Oil Co. Eagle Springs unit oil-exploration well No. 2)



Weather stations in and adjacent to the study area. (Triangles indicate precipitation-storage gages; circles indicate standard weather stations. Numbers correspond to those in table 2.)



Contour interval 200 feet
Supplementary contours at 100-foot intervals
Datum is mean sea level

Base from U.S. Geological Survey 1:250,000 series maps: Caliente (1962), Ely (1962), Goldfield (1962), Lund (1962), and Tonopah (1962).

Consolidated-rock geology based on maps of Kleinhampl and Ziony (1967), Cornwall (1967), Tschanz and Pampeyan (1961), and Hose and Blake (1970). Alluvial geology by Rush in 1974. Hydrology by Van Denburgh and Rush in 1971-72.

Cartography by Marjorie Thielke

PLATE 1.--GENERALIZED HYDROGEOLOGIC MAP OF RAILROAD AND PENOYER VALLEYS, EAST-CENTRAL NEVADA

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