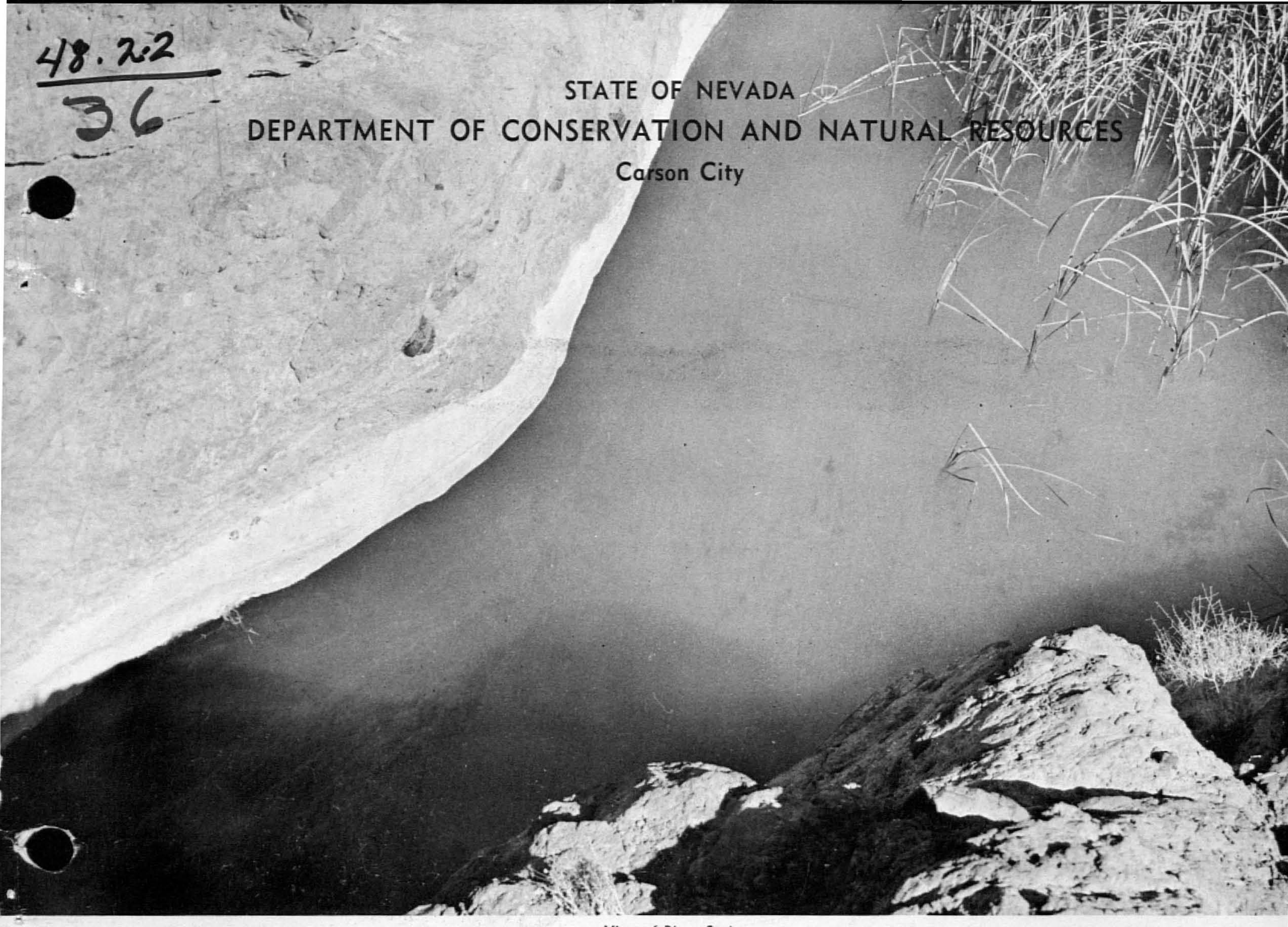
STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Carson City



View of Piute Spring.

WATER RESOURCES–RECONNAISSANCE SERIES
REPORT 36

GROUND–WATER APPRAISAL OF THE ELDORADO–PIUTE VALLEY AREA, NEVADA AND CALIFORNIA

By
F. Eugene Rush
and
Charles J. Huxel, Jr.
Geologists

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

FEBRUARY 1966

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GROUND-WATER APPRAISAL OF THE ELDORADO-PIUTE VALLEY AREA, NEVADA AND CALIFORNIA

By F. Eugene Rush and Charles J. Huxel, Jr.

SUMMARY

The Eldorado-Piute Valley area is in the extreme southern part of Nevada and the adjoining part of California, and has an area of about 2,000 square miles. Eldorado Valley is topographically closed and has a central playa. Piute Valley drains to the Colorado River near Needles, California.

The valleys are arid, whereas the mountains are semiarid. The unconsolidated alluvium, where saturated, forms the best aquifer in the area. The consolidated rocks are relatively impermeable and, except where they give rise to springs, are not important as sources of ground water.

The estimated average annual ground-water recharge is 1,100 acre-feet in Eldorado Valley, 2,400 acre-feet in Piute Valley, and 200 acre-feet in the adjacent part of the Colorado River valley. Ground-water discharge from Eldorado Valley occurs by subsurface outflow to the east through volcanic rocks beneath the Eldorado Mountains to the Colorado River. If half the outflow could be salvaged, the estimated perennial yield would be about 500 acre-feet per year. Ground-water discharge from the Nevada part of Piute Valley by subsurface outflow to California is about 1,200 acre-feet per year. Only a small part of the outflow could be salvaged by pumping and therefore the yield is only a few hundred acre-feet per year.

The present development of ground water in the area is less than 100 acre-feet per year, and most of this is pumped by the town of Searchlight. Boulder City imports water from Lake Mead (about 2,300 acre-feet per year in 1960-64). The Southern Nevada Water Supply Project, approved by the U. S. Congress in 1965, is expected to supply as much as 40,000 acre-feet per year to this area in the future.

The total amount of recoverable ground water in the upper 100 feet of saturated alluvium is estimated to be about 1 million acre-feet in Eldorado Valley, about 1.5 million acre-feet in Piute Valley, and about 1 million acre-feet in the adjacent segment of the Colorado River valley. For Piute Valley, about 750,000 acre-feet is in Nevada.

The chemical quality of the ground water is considered only fair to poor for agricultural use. In general, the quality is considered generally fair to poor for domestic use, principally because it is high in total solids.

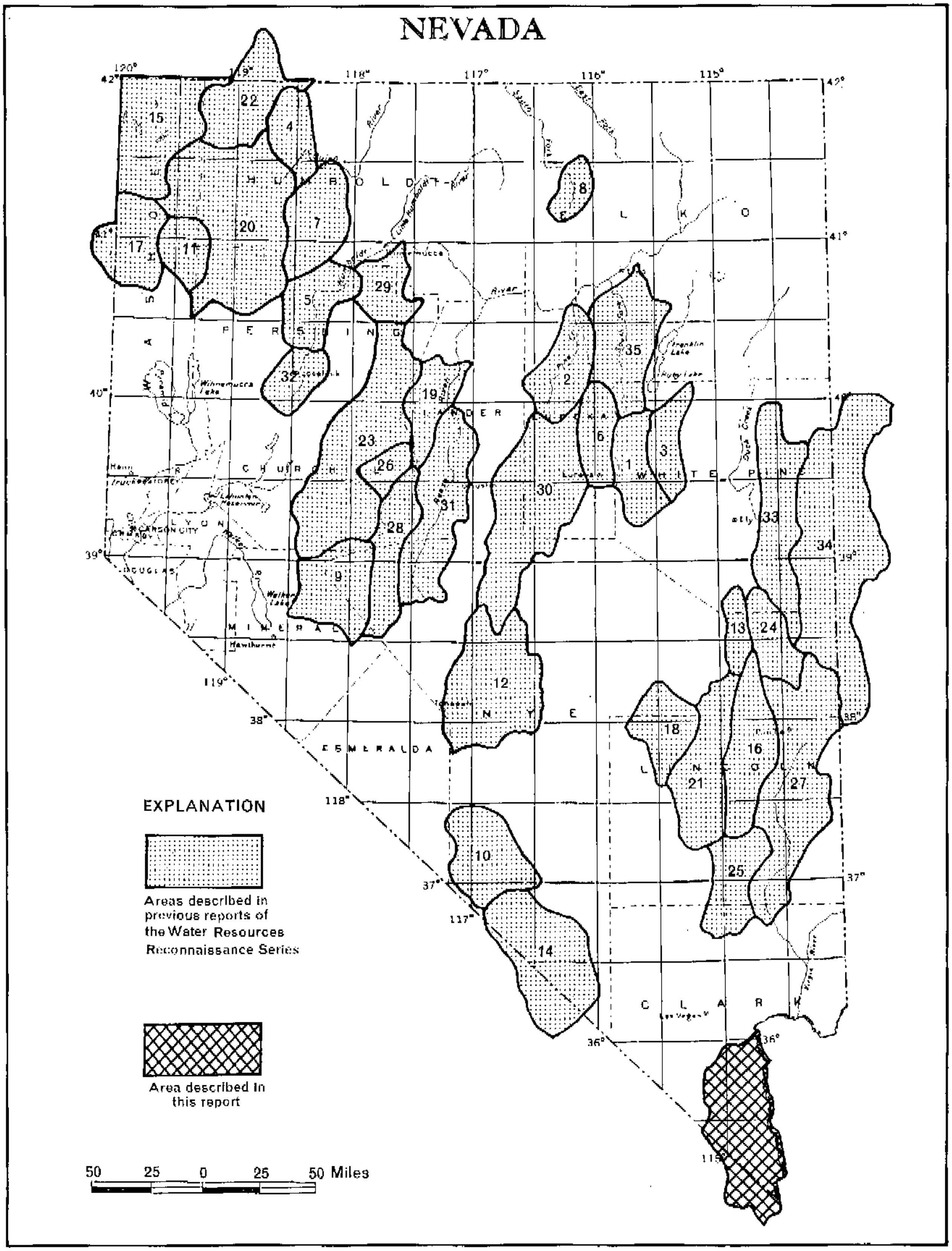

Figure 1.— Areas in Nevada described in previous reports of the Water Resources Reconnaissance Series and the area described in this report

INTRODUCTION

Purpose and Scope of the Study

Prior to 1960, one of the greatest deficiencies in water knowledge in Nevada was the lack of quantitative hydrologic data for more than half of the valleys in the State. In an effort to overcome this deficiency, legislation was enacted in 1960 to provide for reconnaissance studies of drainage basins in Nevada under the cooperative program between the Nevada Department of Conservation and Natural Resources and the U. S. Geological Survey. The purpose of these studies is to provide water-resources information to the public and to assist the State Engineer in the administration of the water law by making preliminary estimates of average annual recharge to, discharge from, and perennial yield of ground water in valleys and basins. In addition to these estimates the scope of the reports includes appraisals and information on (1) climate, (2) geologic environment, (3) extent of the hydrologic systems, (4) ground water in storage, (5) streamflow and runoff, (6) water quality, and (7) areas of potential development.

This report is the 36th in the series of reconnaissance studies (fig. 1). Field work was limited to a 1-week study of the hydrologic conditions and the geologic environment of the area and was done in May 1965.

Location and General Features

The area covered by this report is in the extreme southern part of Nevada and the adjoining part of California. It is composed of three major segments: Eldorado Valley, Piute Valley, and that part of the Colorado River valley adjacent to Eldorado and Piute Valleys. In this report the entire area is called the Eldorado-Piute Valley area. It is enclosed by long 114°30' and 115°15' W., and lat 34°45' and 36°00" N. (fig. 1), and is in southern Clark County, Nevada, and northeastern San Bernardino County, California. Eldorado Valley is topographically closed, whereas the other areas are tributary to the Colorado River.

The report area is about 90 miles long in a north-south direction and averages about 25 miles wide. Eldorado Valley has an area of about 530 square miles, Piute Valley 770 square miles, and that part of the Colorado River valley in the report area 650 square miles; a total of 1,950 square miles.

Principal access to the area is by U. S. Highway 95, which extends the length of the area from Henderson, Nevada, to Needles, California, and State Highway 68 which crosses the area at Searchlight and Davis Dam (fig. 2). Paved roads extend eastward from U. S. Highway 95 through Boulder City to Hoover Dam, through Nelson to Nelson's Landing, and from Searchlight to Lake Mohave. Numerous graded roads and unimproved trails extend to most parts of the area.

The principal communities are Boulder City, at the north end of Eldorado Valley, and Needles, near the south end of Piute Valley. Las Vegas is about 20 miles north of the area (fig. 1). Searchlight, a small community, is near the center of the area. Few ranches are in the area; most of the population is in the several communities. Boulder City has a population of about 6,000; Needles, about 5,000; and Searchlight, about 250.

Previous Work

The Eldorado-Piute Valley area has been the subject of several reports describing the geology, potential surface-water development, and mineral resources. Little has been written about the ground-water resources, because it has had little development.

One of the early descriptions of the geology in southern Clark County was made by Callaghan (1939) of the Searchlight District. Later Bowyer and others (1958) mapped the geology of Clark County. Recently the geology was mapped and described in the area between Lake Mead and Davis Dam by Longwell (1963).

The mining districts of Eldorado Canyon, Railroad Pass, and Searchlight have been described by Lincoln (1923), Hewett and others (1936), and McKelvey and others (1949), respectively.

In reports describing desert watering places for travelers in the early days of the automobile, Thompson (1921, p. 239) described the location of Piute Spring. (See cover photo.) This spring is the largest known discharge point of ground water in the report area. Worts (1962) made a brief ground-water study of Eldorado Canyon for the National Park Service, and describes the possible sources for a water supply in that area.

Reports on potential land and water development in the report area have been prepared by Shamberger (1954), Tippets-Abbett-McCarthy-Stratton Engineers (1958), and the U. S. Department of Interior (1964).

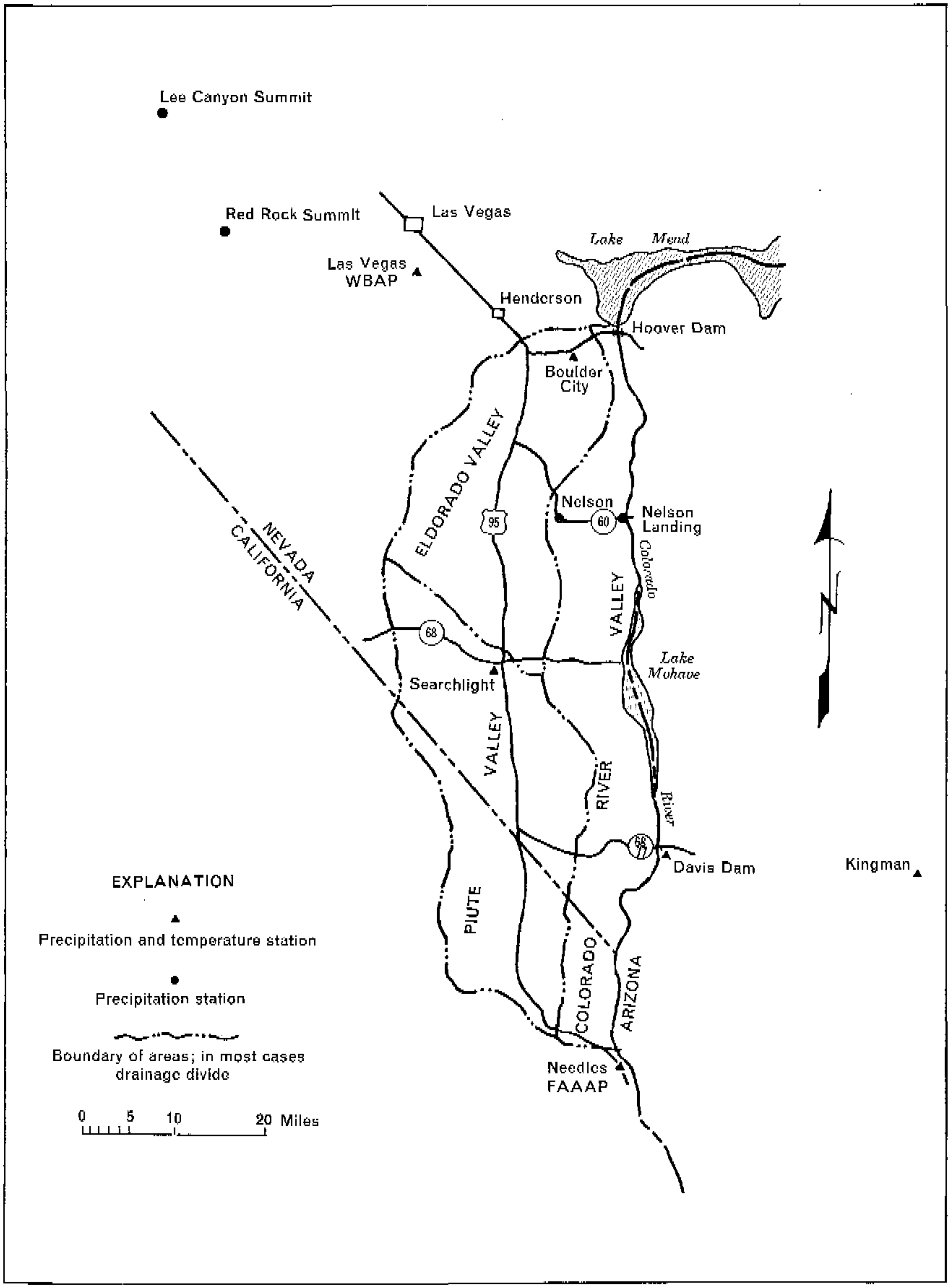

Figure 2.—Location of weather stations and paved roads

Hydrology investigations have been made in several adjacent areas. Ground-water conditions in Lanfair Valley were described by Thompson (1921). In Las Vegas Valley, well data and water-level information were published by Maxey and Jameson (1946) and Robinson and others (1947). Ground-water investigations were reported on by Maxey and Robinson (1947), Maxey and Jameson (1948), and Malmberg (1961 and 1965). Malmberg (1964) also described the relation of ground-water development to land subsidence. The ground-water conditions in the vicinity of the Lake Mead Base, about 10 miles northeast of Las Vegas, were described by Loeltz (1963).

Lake Mead has been the subject of several studies; a report by Harbeck and others (1958) describes the evaporation losses from the lake, Smith and others (1960) the accumulation of sediments in the lake, and U. S. Weather Bureau (1953) the wind patterns over lower Lake Mead.

Climate

The air masses that move across southern Nevada are characteristically deficient in moisture. The valleys are arid whereas the mountain areas are semiarid, receiving somewhat more precipitation, especially in the winter. Thunderstorms provide most of the precipitation in the summer.

Precipitation has been recorded at eight stations in and adjacent to the Eldorado-Piute Valley area. These stations are shown on figure 2. The average annual precipitation at these stations ranges from about 3 inches to over 20 inches. A further discussion of precipitation is included in the hydrology section of this report.

Temperature data have been recorded at Boulder City, Las Vegas, and Searchlight, Nevada, and at Needles, California. Since 1949, the U. S. Weather Bureau has been publishing freeze data; this information is given in table 1. Because killing frosts vary with the type of crop, temperatures of 32°F, 28°F, and 24°F are used to determine the number of days between the last spring minimum (prior to July 1) and the first fall minimum (after July 1).

Table 1. -- Number of days between the last spring minimum and the first fall minimum temperatures for several stations in the vicinity of the Eldorado-Piute Valley area

(From published records of the U.S. Weather Bureau)

Year	Boulder City			Davis Dam			Las Vegas			Needles			Searchlight		
	32°F	28°F	24°F	32°F	28°F	24°F	32°F	28°F	24°F	32°F	28°F	24°	32°F	28°F	24°F
1949	297	299	320				244	296	298	299	300	335	261	299	299
1950	333	339	361				241	243	282	284	334	360	242	333	334
1951	267	-	-				229	261	284	318	365	365	258	278	281
1952	269	-	-				255	267	321	267	365	365	239	246	323
1953	-	-	-	271	305	-	224	277	289	271			224	261	300
1954	290	-	-	-	-	-	257	278	348	356	365	365	249	290	365
1955	240	-	-	365	-	-	227	240	284	199	365	365	208	209	365
1956	252	-	-	-	-	-	232	236	277	283	365	365	235	252	252
1957	-	-	-	-	-	-	285	296	365	365	365	365	230	365	365
1958	299	-	-	-	-	-	249	298	301	365	365	365	248	259	365
1959	-	-	-	-	-	-	277	-	-	365	365	365	250	340	357
1960	285	-	-	363	-	-	279	-	-	365	365	365	278	285	286
1961	-	-	-	-	-	-	263	313	343	365	365	365	-	-	-
1962	289	301	-	-	-	-	273	285	299	301	365	365	242	287	299
1963	239	-	-	-	-	-	262	282	319	341	365	365	236	325	353
1964	245	-	-	-	-	-	234	279	303	291	365	365	234	251	276
Average	275	-	-	-	-	-	251	275	308	314	355	362	242	285	321

A crop experiencing a killing frost at 28°F probably will have an average growing season of about 280 to 300 days at Searchlight and Boulder City. Searchlight is on the low bedrock divide between Eldorado and Piute Valleys. Boulder City is on the divide between Eldorado Valley and Lake Mead. During periods of little or no wind movement heavy cold air flows into the lower parts of the valleys, thus causing temperatures on the valley floors to be lower than on the higher areas surrounding them. For this reason the average length of the growing season on the valley floor of Eldorado Valley probably is shorter than at Searchlight and Boulder City. At Las Vegas on the valley floor, the average growing season for a crop experiencing a killing frost at 28°F is about 275 days. The average length of the growing season on the valley floor of Eldorado Valley and at Las Vegas probably are about the same. Because of its more southerly latitude and lower altitude, the average length of growing season in the southern part of Piute Valley probably is longer than in Eldorado Valley. Incomplete data at Davis Dam and continuous records at Needles indicate that the growing season in the Colorado River valley is much longer than in either Eldorado or Piute Valleys.

The data given in table 1 suggest that the average length of growing season for crops experiencing a killing frost at 28°F on the upper alluvial aprons and low bedrock divides surrounding Eldorado and northern Piute Valleys is about 300 days; in the lower parts of these valleys the average length is about 275 days; and in the lower parts of the Colorado River valley and southern Piute Valley the length may be as much as 330 days.

The average annual temperature range in the Eldorado-Piute Valley area can be expected to vary from a low of 10°F to a high of about 115°F in the northern part of the area, and from a low of 20°F to a high of 120°F in the southern part.

Numbering System for Wells and Springs

The numbering system for wells and springs in this report is based on the rectangular subdivisions of the public lands, referenced to the Mount Diablo base line and meridian in Nevada and the San Bernardino base line and meridian in California. It 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 section number. The section number is followed by a letter that indicates the quarter section, the letters a, b, c, and d designating the northeast, northwest, southwest, and southeast quarters, respectively. Following the letter, a number indicates the order in which the well or spring was recorded within the 160-acre-tract. For example, in Nevada well 24/63-23c1 in table 6 is the first well recorded in the SW 1/4 sec. 23, T. 24 S., R. 63 E., Mount Diablo base line and meridian.

Because of the limitation of space, wells and springs are identified on plate 1 only by the section number, quarter section letter, and number indicating the order in which they were located. Township and range numbers are shown along the margins of the area on plate 1.

GENERAL HYDROGEOLOGIC FEATURES

Physiography and Drainage

The report area is in the Sonora Desert section of the Basin and Range physiographic province (Fenneman, 1931). Eldorado Valley is bounded on the west by the McCullough Range and on the north by the Black Hills and the River Mountains (pl. 1). It is separated from Piute Valley by the Highland Range and a low bedrock outcrop extending north westward from Searchlight, and from the Colorado River valley by the Eldorado Mountains. Peaks in the Eldorado Mountains attain altitudes of over 5,000 feet. The highest peak in the McCullough Range is McCullough Mountain at 7,060 feet. The valley floor of Eldorado Valley is between 1,708 and 1,760 feet. A playa called Dry Lake occupies the lowest part of the valley floor.

Piute Valley is bounded on the west by a southern extension of the McCullough Range, the Castle Mountains, and the Piute Range (pl. 1). The southwestern mountains are breached by two low alluvial divides. On the east the valley is separated from the Colorado River valley by the Newberry and Dead Mountains. The Sacramento Mountains terminate the valley in the south. The highest peaks in the mountains bordering the western edge of the valley range from 4,800 to 5,900 feet in altitude. Peaks in the Newberry and Dead Mountains range in altitude from 3,200 to nearly 5,000 feet. Piute Wash, which drains Piute Valley and part of Lanfair Valley, enters the Colorado River valley at an altitude of 1,200 feet between the Dead and the Sacramento Mountains.

The part of the Colorado River valley included in this report extends from Hoover Dam (formerly Boulder Dam) on the north to Needles, California on the south and is restricted to the west side of the river in Nevada and California. From the mouth of Black Canyon to the Newberry Mountains the valley consists of a rather poorly defined basin with well graded valley slopes. The central part of this basin is occupied by Lake Mohave. South of Davis Dam and the Newberry Mountains the valley widens to form another basin, the floor of which is the flood plain of the Colorado River. This basin extends southward out of the report area to the Mohave Mountains in the Chemehuevi Range. The lowest point in the area is the Colorado River near Needles where the altitude is about 480 feet.

With the exception of the Colorado River, all streams in the Eldorado-Piute Valley area are intermittent and carry water only after snow or rain storms. The channels of streams consist of steep-walled canyons in the mountains and washes filled with coarse flood-deposited debris on the valley slopes. When the streams in the area flow, most of the water is absorbed by the alluvial deposits underlying the valley slopes.

All drainage in Eldorado Valley is toward Dry Lake playa. Piute Valley is part of the Colorado drainage system. The drainageways of the mountains connect to Piute Wash, which as mentioned previously, extends to the Colorado River near Needles. The short canyons and washes draining the west slopes of the Colorado River valley extend to the river.

Lithologic and Hydrologic Features of the Rocks

Consolidated Rocks

The consolidated rocks of the area fall into four categories. A complex of Precambrian igneous and metamorphic rocks consisting of gneiss, schist, and granite composes the southern Eldorado Range, the Newberry and the Dead Mountains, and the southern part of the McCullough Range. Plutonic granite of Mesozoic age has locally intruded the Precambrian igneous-metamorphic complex. Tertiary volcanic rocks, including flows and pyroclastics, compose the northern Eldorado and McCullough Ranges, the River Mountains, the Highland and Piute Ranges, and the Castle Mountains. Tertiary sedimentary rocks consisting of nonmarine clastics, in some places interbedded with flow and pyroclastic rocks, and fresh-water limestone are found in the southern part of the area. The only sedimentary rocks in the northern part of the area are beds of "gypsiferous and manganiferous tuff, clay, silt, and sand" (Longwell, 1963, p. E9). These rocks are found south of Boulder City and are included in the Muddy Creek Formation.

In general, the consolidated rocks of the Eldorado-Piute Valley area are relatively impermeable, and except for springs or shallow dug wells, they are not important as sources of ground water. Except possibly for Eldorado Valley, little ground-water movement occurs through the consolidated rocks. They are shown as one unit on plate 1.

Alluvium

All unconsolidated to semiconsolidated alluvial deposits of the area are grouped as alluvium, which also is mapped as one unit on plate 1. The alluvium probably ranges in age from Pliocene to Recent; most of the exposed material is believed to be of Quaternary age. Alluvial aprons of

Eldorado and Piute Valleys and the Colorado River valley east of Searchlight are underlain by lenticular beds of gravel, sand, silt, and clay eroded from adjacent mountains. Coarse alluvial materials are contained in numerous washes cutting the alluvial aprons. Lacustrine clay mixed with coarser materials derived from influent washes underlies the playa in Eldorado Valley. Locally, older alluvial terrace deposits, scattered lake deposits, and dissected alluvial-fan deposits occur in the southern part of Piute Valley and in the Colorado River valley.

Alluvium forms the principal ground-water reservoir. On the floor of Eldorado Valley, its entire thickness was penetrated in test well 24/63- 29b1 (tables 6 and 7). According to the driller's log, rhyolite was encountered at a depth of 1,040 feet. The limited data indicate that the clayey playa and lake deposits of low permeability may have a miximum thickness of about 400 feet in the vicinity of Dry Lake playa. Below this depth, sand and gravel of moderate permeability probably are common. Test well 24/63-29a1 encountered the first water at a depth of 475 feet below land surface. The water rose 200 feet to a static level of about 275 feet below land surface. It was test pumped for 14 hours at 920 gpm (gallons per minute) with a drawdown of 95 feet. The lithology of the water-yielding zone is not known, because fluid circulation was lost and further drilling was therefore prevented. However, data obtained during the pumping test indicate that the aquifer or aquifers had an estimated coefficient of transmissibility of 55,000 gallons per day per foot, hence are fairly good sources of water.

Other attempts at developing large water supplies in Eldorado Valley have generally been unsuccessful. However, moderate but ample supply has been developed from wells for public-supply use at Searchlight.

HYDROLOGY

Precipitation

As stated previously, precipitation has been recorded at eight stations in the vicinity of the Eldorado-Piute Valley area. Two of these stations, Boulder City and Searchlight, are within the area, as shown on figure 2. Long-term variations in the precipitation pattern are illustrated by cumulative departure curves of the records at Las Vegas and Kingman, Arizona (fig. 3). They indicate that two periods of subnormal precipitation occurred during the period 1913 to 1964, one in 1923-30 and the other in 1942-64.

Table 2 shows that the average monthly and seasonal precipitation varies greatly. Regional storms during the winter and spring contribute larger amounts of precipitation than those occurring in early summer and fall. Thunderstorms during the summer contribute a moderate amount of precipitation to the valleys of southern Nevada.

The precipitation pattern in Nevada is related principally to the topography--the stations at the highest altitudes generally receive more precipitation than those at lower altitudes. The graph in figure 4 illustrates the relation between altitude and precipitation in the Eldorado-Piute Valley area.

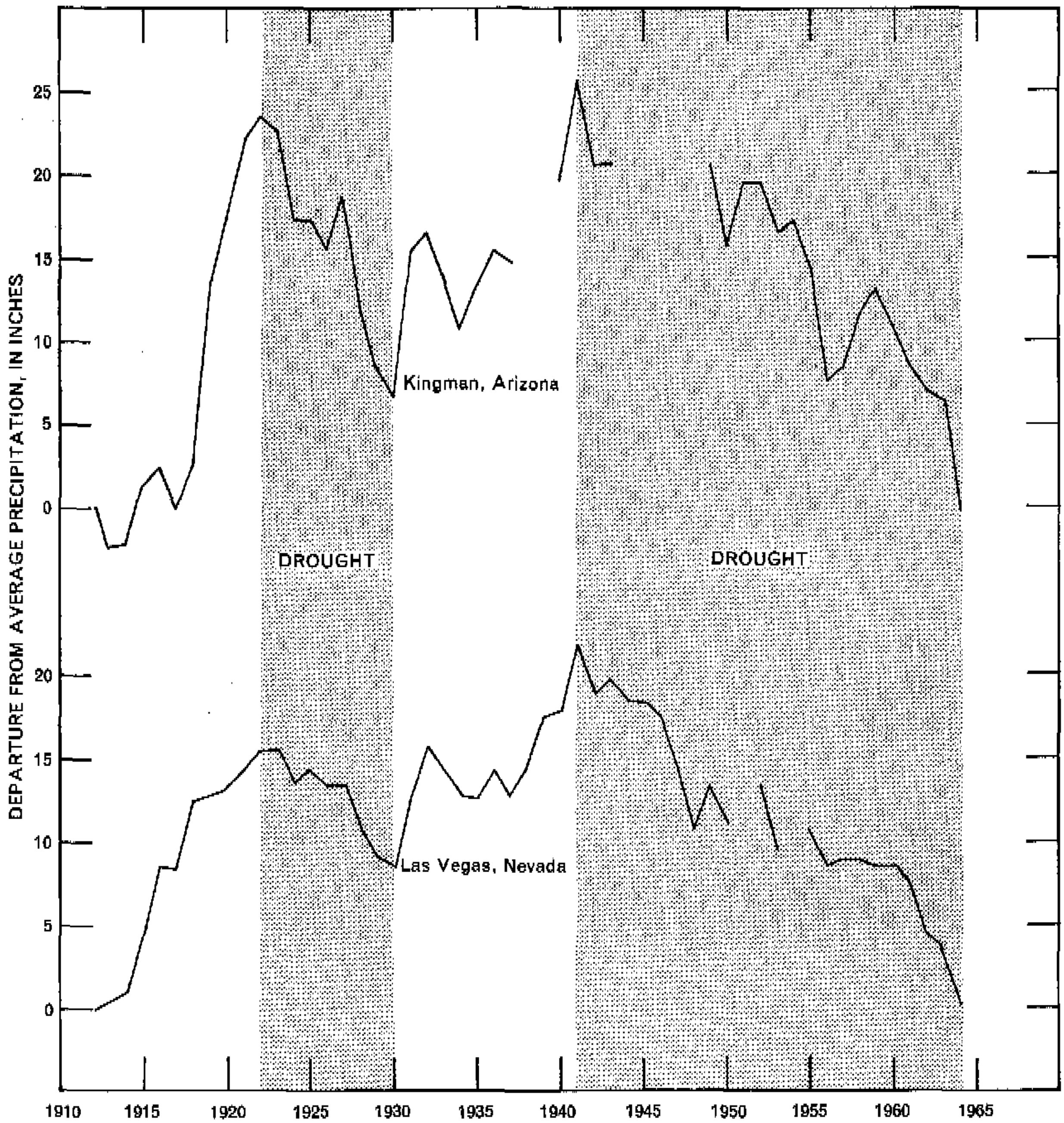

Figure 3.—Cumulative departure from average precipitation at Las Vegas, Nevada and Kingman, Arizona for the period 1913-1964

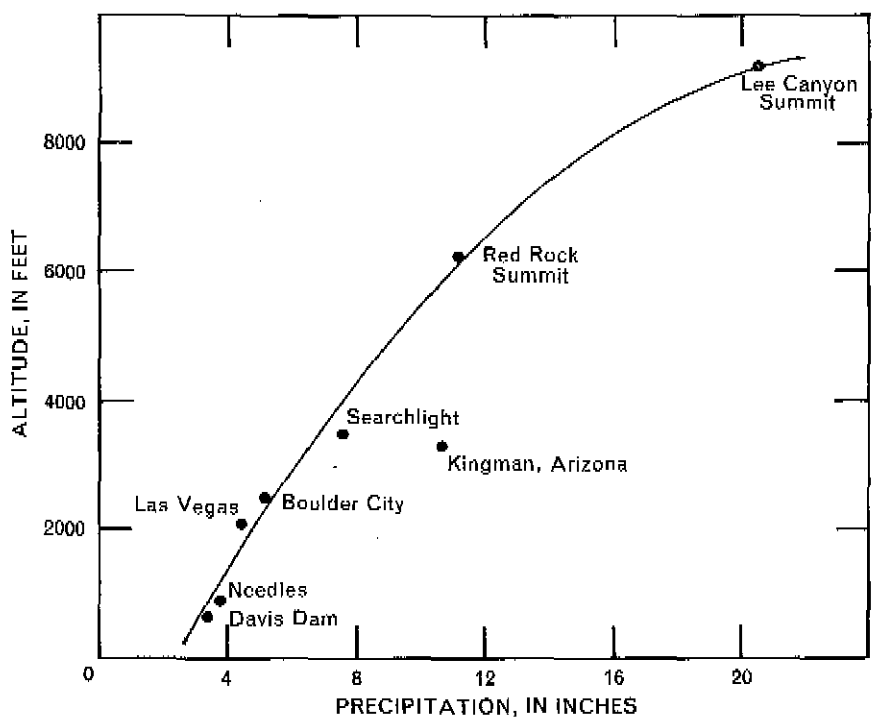

Figure 4.—Relation of station altitude to the measured amount of average annual precipitation

Table 2.--Average monthly and annual precipitation at stations in the vicinity of the Eldorado-Piute Valley area

(From published records of the U. S. Weather Bureau)

Station name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Needles FAAAP, Calif. 1/	0.51	0.30	0.25	0.12	0.07	0.01	0.37	0.74	0.23	0.41	0.31	0.39	3.71
Kingman, Arizona 2/	1.21	1.42	1.05	.64	.27	.16	.91	1.50	.98	.67	.58	1.19	10.58
Davis Dam, Arizona 3/	.49	.36	.49	.14	.07	.01	.19	.52	.27	.31	.32	.29	3.46
Searchlight, Nev. 4/	.90	.83	.69	.46	.21	.14	.96	1.16	.61	.50	.41	.74	7.61
Boulder City, Nev. 5/	.66	.52	.51	.34	.16	.06	.52	.59	.50	.37	.40	.54	5.17
Las Vegas WBAP, Nev. 6/	.49	.34	.41	.22	.68	.03	.48	.45	.38	.27	.32	.36	4.43
Red Rock Summit 7/	1.20	.73	1.39	.76	.41	.25	1.08	1.29	.48	1.14	.64	1.75	11.12
Lee Canyon Summit 8/	2.58	2.19	2.22	1.21	.89	.48	2.05	1.63	.59	1.89	1.46	3.30	20.49

	Altitude	Location	Period of record
1.	913 feet	sec. 19, T. 6 N., R. 23 E.	21 years, 1944-64
2.	3,326 feet	sec. 24, T. 21 N., R. 17 W.	61 years, 1901-44, 1948-64
3.	657 feet	sec. 18, T. 21 N., R. 21 W.	12 years, 1953-64
4.	3,540 feet	sec. 34, T. 28 S., R. 63 E.	51 years, 1914-64
5.	2,525 feet	sec. 5, T. 23 S., R. 64 E.	34 years, 1931-64
6.	2,162 feet	sec. 34, T. 20 S., R. 61 E.	28 years, 1937-64
7.	6,240 feet	sec. 13, T. 21 S., R. 57 E.	10 years, 1945-54
8.	9,200 feet	sec. 9, T. 19 S., R. 56 E.	9 years, 1945-53

The area having the highest ground water in the alluvium is northern Piute Valley, where it is at an altitude of more than 3,000 feet. Eldorado Valley has water levels in the alluvium ranging between an altitude of 1,400 feet beneath the playa and 2,000 feet along the south-west side. This is generally lower than Piute Valley as a whole. In the Colorado River valley, water levels are as low as about 600 feet. There is no evidence to indicate that ground water flows between Piute and Eldorado Valleys, but rather it is assumed that the ground water flows eastward from Eldorado Valley to the Colorado River valley where water levels are much lower. This movement would have to be accomplished by flow through rock fractures in the otherwise relatively impermeable volcanic rocks of the Eldorado Mountains.

The flow from Piute Valley may also be by eastward movement through igneous and metamorphic rocks to the Colorado River valley; however, the movement is more likely to be southward through alluvial fill along Piute Wash southeast of Arrowhead Junction, and eastward from the southern part of Piute Valley to the Colorado River.

Recharge

Ground water in the Eldorado-Piute Valley area, with the exception of the Colorado River valley, is derived from precipitation within the drainage basin. Runoff from precipitation in the mountains and to a lesser extent precipitation on the alluvial aprons provides most of the recharge. In the Colorado River valley inflow of the river is the main source of both ground and surface water.

Snow and rain in the mountains in part infiltrates the rock material and in part collects into small short streams which generally are absorbed on the alluvial fans. Most of this water is evaporated before and after infiltration, some adds to soil moisture, and some percolates to the water table and recharges the ground-water reservoir.

Little of the precipitation occurring in the lower parts of the valleys reaches the water table; rather, it is held in the alluvium as soil moisture and is used by the plants or is evaporated. The water that reaches the main washes and stream channels generally is absorbed by the alluvium as it flows toward the lowest parts of the valleys and in part enters ground-water storage.

Although precipitation is the principal source of recharge to the ground-water reservoirs in Eldorado and Piute Valleys, and a minor source in this segment of the Colorado River valley, only a small percentage reaches the ground-water reservoir. A method described by Eakin and others (1951, p. 79-81) is used to estimate recharge in this report. The method assumes that a fixed percentage of the average annual precipitation recharges the ground-water body. Hardman (1936) showed that in gross aspect the average annual precipitation in Nevada is related closely to altitude and that precipitation can be estimated with a reasonable degree of accuracy by assigning precipitation rates to various altitude zones.

Based on the precipitation-altitude curve in figure 4 the distribution of average annual precipitation is delineated as follows: 8 inches at an altitude of 4,000 feet, 10 inches at 5,000 feet, 12 inches at 6,000 feet, and 14 inches at 7,000 feet. Three precipitation zones were selected, using the above values. The zones, the estimated precipitation, and the estimated recharge for the area are summarized in table 3.

The preliminary estimate of the average annual precipitation in the Eldorado-Piute Valley area is about 600,000 acre-feet. The estimated average annual ground-water recharge from precipitation for the report area is about 3,000 acre-feet, of which 1,100 acre-feet occurs in Eldorado Valley, 1,700 acre-feet in Piute Valley, and 200 acre-feet in the adjacent segment of the Colorado River valley. Thus, the estimated recharge is only about 0.5 percent of the precipitation. The principal areas of recharge are the McCullough and Castle Mountains adjoining the southwestern part of Eldorado Valley and northwestern part of Piute Valley, the Eldorado Mountains adjoining the southeastern part of Eldorado Valley, and the Highland Range.

Additional recharge to Piute Valley probably occurs from Lanfair Valley. As previously pointed out in the section on ground-water occurrence and movement, the mountain area draining to Piute Springs is small and therefore would sustain only a fraction of the observed flow. The bulk of the flow, about 700 acre-feet per year, probably is from Lanfair Valley. This amount plus the 1,700 acre-feet of recharge from precipitation suggests an estimated total average annual recharge for Piute Valley of about 2,400 acre-feet.

The ground-water reservoir in the Colorado River valley is recharged principally by seepage from the Colorado River. No estimate is made in this report of the magnitude of this recharge.

Boulder City obtains its water supply from the Colorado River. For the years 1960-64, the average importation of water to Boulder City, and therefore to Eldorado Valley, was about 2,300 acre-feet per year as measured at the filtration plant. According to the Public Health Service (1963, p. 94), in 1962 about 500 acre-feet of this volume reached the sewage treatment plant and was supplied to oxidation ponds in sec. 9,

T. 23 S., R. 64 E., where it is allowed to evaporate or percolate into the alluvium. This probably was a typical amount for the period 1960-64. Moreover, some of the water applied to lawns and for other uses percolates into the ground and eventually reaches the ground-water system. The amount of percolation is not known, but even a small fraction of the total may be a significant source of artificial recharge compared to the 1,100 acre-feet of estimated natural recharge. The combined recharge of the several sources probably is more than 1,500 acre-feet per year.

Thus, for the period 1960-64 the average annual recharge to the area probably totaled more than 4,000 acre-feet. The total natural recharge is limited to the recharge from precipitation, an estimated 3,000 acre-feet per year (table 3), plus the inflow to Piute Spring from Lanfair Valley, about 700 acre-feet per year, or a total of about 3,700 acre-feet per year. For Piute Valley, about 50 percent of the natural recharge, or 1,200 acre-feet per year, occurs in Nevada and an equal amount occurs in California.

Table 3.--Estimated average annual precipitation and ground-water recharge in the Eldorado-Piute Valley area

Precipitation zone (feet)	Area (acres)	Estimated annual precipitation: Range (inches)	Estimated annual precipitation: Average (feet)	Estimated annual precipitation: Average (acre-feet)	Estimated recharge from precipitation: Percentage of precipitation	Estimated recharge from precipitation: Acre-feet per year
		ELDORADO VALLEY				
Above 6,000	1,900	More than 12	1.08	2,000	7	140
4,000 to 6,000	42,000	8 to 12	.83	35,000	3	1,000
Below 4,000	293,000	Less than 8	.50	150,000	Minor	--
Subtotal (rounded)	337,000			190,000		1,100
		PIUTE VALLEY				
Above 6,000	800	More than 12	1.00	800	7	60
4,000 to 6,000	66,300	8 to 12	.83	55,000	3	1,600
Below 4,000	426,000	Less than 8	.42	180,000	Minor	--
Subtotal (rounded)	493,000			240,000		1,700
		COLORADO RIVER VALLEY				
Above 4,000	7,700	More than 8	.75	5,800	3	170
Below 4,000	407,000	Less than 8	.42	170,000	Minor	--
Subtotal (rounded)	415,000			180,000		200
Total (rounded)	1,245,000			610,000		3,000

Discharge

Very little development of ground water has occurred in the study area. Natural discharge is chiefly by subsurface outflow. The volume of natural discharge could not be directly estimated, and therefore is taken to be equal to the estimated natural recharge of about 3,700 acre-feet per year.

Evapotranspiration -- Only a minor amount of ground water is discharged by transpiration of phreatophytes. Some saltbrush grows in the mountain areas where the depths to water is less than about 50 feet. The areas where such conditions exist are small; the total discharge is negligible.

Springs -- Many springs are in the mountains of the area (pl. 1), but most have very small flows and their total discharge is small. The largest spring of the area is Piute Spring, 12/18-24bl (Calif.), in the Piute Range. It was observed to have a flow of about 1 cfs in May 1965, but the water is mostly absorbed by the coarse alluvium in the canyon before it leaves the mountain area. In the canyon a lush growth of cottonwood, willow, and brush consumes part of the flow. Spring 10/21-34dl, described by Mendenhall (1909, p. 67) and Thompson (1921, p. 123) as being at Klinefelter, though not visited as part of the field work, probably does not discharge a large amount of ground water.

Discharge by wells -- Discharge by wells is small, probably not exceeding 100 acre-feet per year. In Eldorado Valley, no known wells are pumped regularly. In Piute Valley only a few stock, domestic, and public-supply wells are used (table 6). The largest withdrawals are made at Searchlight for public supply, possibly 50 acre-feet per year. Along the Colorado River, a few wells supply water at Cottonwood Landing and at scattered dwellings.

Subsurface and surface outflow -- Eldorado Valley is closed topographically; that is, all surface runoff is contained within the valley. Infrequent large flows reach Dry Lake playa where the water evaporates. As previously mentioned, the depth to water beneath the playa is at least 270 feet, clearly indicating that none of the natural recharge, estimated to be 1,100 acre-feet per year, discharges by evapotranspiration. Thus, all the recharge must leave the area by ground-water flow. The bulk of the subsurface flow is presumed to be eastward chiefly through the volcanic rocks of the Eldorado Mountains toward the Colorado River, whose surface is 800 feet lower than the ground-water altitude in wells in Eldorado Valley.

Because periodic water-level measurements have not been made in Eldorado Valley, the effect of infiltration of sewage effluent over the past 30 years on the ground-water levels is not known. This water adds to the water in storage in the ground-water reservoir and eventually may increase the discharge by subsurface outflow.

Piute Valley is open to the southeast, both topographically and hydrologically. The valley is drained by Piute Wash, which reaches the Colorado River near Needles.

Ground-water discharge by evapotranspiration does not occur from the ground-water reservoir in the alluvium. Hence, ground-water also must move southward to discharge at spring 10/21-34dl, but mostly in other areas. The amount involved in underflow probably is close to 2,400 acre-feet per year. At the south end of Piute Valley the ground-water underflow probably moves eastward and discharges into the Colorado River. Part of the flow may move eastward from Piute Valley through the igneous and metamorphic rocks of the Eldorado Range and the Newberry and Dead Mountains to the Colorado River valley.

In the segment of the Colorado River valley, the small contribution of roughly 200 acre-feet per year of recharge either enters the river by subsurface flow or is consumed by evapotranspiration along the west bank of the river. The principal phreatophytes in this area are mesquite and saltcedar.

Perennial Yield

The perennial yield of a ground-water reservoir is the maximum amount of water of usable chemical quality that can be withdrawn and consumed economically each year for an indefinite period of time. If the perennial yield is continually exceeded, water levels will decline until the ground-water reservoir is depleted of water of usable quality or until the pumping lifts become uneconomical to maintain. Perennial yield cannot exceed the natural recharge to an area indefinitely and ultimately is limited to the maximum amount of natural discharge that can be salvaged for beneficial use.

For Eldorado Valley, where the minimum depth to water is at least 270 feet below land surface, the estimated recharge of 1,100 acre-feet per year (table 3) is postulated to move eastward to discharge into the Colorado River. The possibility of salvaging all or part of the outflow by pumping in Eldorado Valley is dependent on the manner in which the flow moves through the volcanic rocks of Eldorado Mountains. If the water is moving over a "spillway" or "lip", most could be salvaged by drawing down the water level below the outlet altitude. On the other hand, if the movement is dispersed throughout a fault system or joint pattern, only a small amount of the discharge could be salvaged by pumping within the valley. Because the salvable discharge lies between these two limits, the preliminary estimate of perennial yield for Eldorado Valley is considered to be about 500 acre-feet.

For Piute Valley, where only about 1,200 acre-feet per year of recharge originates in Nevada and is moving southward into California, only a few hundred acre-feet of the outflow could be salvaged. Thus, the estimated perennial yield is also limited to a few hundred acre-feet.

For the adjacent segment of the Colorado River valley, where the estimated recharge of about 200 acre-feet per year (table 3) moves eastward to discharge into the Colorado River, all could be salvaged by pumping along the west bank of the river. Moreover, the subsurface out-flow from Eldorado and Piute Valleys could be salvaged by the same process. However, the legality of any ground-water withdrawals along the Colorado River would have to be evaluated. Thus, no estimate of yield is made for this part of the area.

Storage

Recoverable ground-water in storage is that part of the stored water that will drain by gravity from the ground-water reservoir in response to pumping. Under native conditions the amount of stored ground-water remains nearly constant. The balance between recharge and discharge, which controls the changes of ground water in storage, probably has been disturbed somewhat by the diversion of small amounts of surface and ground water and by the addition of water by percolation from the watered lawns and the sewage disposal ponds near Boulder City.

The recoverable ground-water in storage is the product of the specific yield, the area of the ground-water reservoir, and the selected saturated thickness of the alluvium. Specific yield of a rock or soil is the ratio of (1) the volume of water which, after being saturated, it will yield by gravity to (2) its own volume (Meinzer, 1923). This ratio is stated as a percentage. In the report area, the average specific yield of the alluvium (the ground-water reservoir) probably is at least ten percent. The areas mapped as alluvium on plate 1 are 198,000 acres in Eldorado Valley, 319,000 acres in Piute Valley, and 200,000 acres in the segment of the Colorado River valley. Because much of the alluvium is believed to be underlain at shallow depth by consolidated rock, the area used to compute storage is taken to be about one-half the above acreages. The selected thickness is the uppermost 100 feet of saturated alluvium. Thus, the estimated amount of recoverable water from this alluvial segment is: Eldorado Valley, about 1 million acre-feet; Piute Valley, about 1.5 million acre-feet; and the adjacent segment of the Colorado River valley, about 1 million acre-feet. In Piute Valley, about one-half or 750,000 acre-feet is in Nevada.

Chemical Quality of the Water

Six water samples were collected and analyzed as part of the present study. The analyses are listed in table 4.

Suitability for agricultural use -- For irrigation use, most sampled sources of ground-water are considered only fair to poor in water quality. Because the sampling is probably not representative of all ground-water sources in the report area, no general conclusion should be based on the limited data of table 4.

The water samples had wide ranges in salinity and alkalinity hazard. Samples from sources that would be developed for irrigation, that is Piute Spring (12/18-24b1), well 24/63-29a1 in Eldorado Valley, and the alluvial areas of Piute Valley (wells 28/62-22c1 and 30/63-9d1) were medium to high in salinity hazard and either low or medium in alkalinity hazard. All samples have a tentative rating of marginal with reference to residual sodium carbonate (RSC), except for samples from Piute Spring and wells 31/65-8b1 and 24/63-29a1. These three samples are rated usable in terms of RSC value.

Suitability for domestic use -- Drinking water should be free from color, turbidity, harmful bacteria, and undesirable odor and taste. The more common chemical constituents affect mostly the taste. The analyses of chemical constituents, as listed in table 4, though incomplete, can be used as a means of rejecting some of the water samples collected in the area. Using the standards suggested by the Public Health Service (1962), samples from wells 26/64-28d1 and 31/65-8b1 would be rejected because of high dissolved solids as reflected by the high specific conductance values and in addition well 31/65-8b1 because of the high sulfate content. In addition, sample from well 24/63-29a1 would be rejected because of high concentrations of chloride, sulfate, and total dissolved solids. The other samples were suitable for the constituents listed on table 4; however, many constituents not analysed for, may cause them to be accepted or rejected. No bacterial analyses were made.

Table 4.--Chemical analysis of water from selected wells and springs in the Eldorado-Piute Valley area

Chemical constituents in parts per million

[Field analyses by the U.S. Geological Survey]

Location well or spring number	Date of collection	Source type	Temperature (°F)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) + Potassium[1] (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: noncarbonate	Specific conductance (micromhos at 25°C)	pH	RSC	Salinity hazard	Alkalinity hazard	Rock source	Water type
10/21-18c1 (Calif.)	4-30-65	well	96	4.0	0.5	101	92	0	80	52	12	0	572	8.0	1.27	Medium	High	Unknown	Mixed
a12/18-24b1 (Calif.)	4-30-65	spring	72	40	22	35	228	16	23	22	192	0	479	8.6	.43	Medium	Low	Alluvium	Bicarbonate
26/64-28d1	4-29-65	well	63	39	37	142	402	21	48	102	249	0	1,050	8.6	2.31	High	Low	Granite	Sodium bicarbonate
28/62-22c1	4-29-65	well	--	6.6	4.3	81	144	4	40	31	34	0	400	8.4	1.81	Medium	Low	Alluvium	Sodium bicarbonate
30/63- 9d1	4-29-65	well	87	3.8	.9	67	114	5	24	22	13	0	334	8.5	1.75	Medium	Medium	Alluvium	Sodium bicarbonate
31/65- 8b1	4-29-65	well	--	121	36	160	257	21	420	81	450	204	1,420	8.6	0	High	Low	Granite	Mixed
b24/63-29a1	3-10-64	well	--	90	34	167	115	0	288	475	364	--	—	8.8	-5.4	High	Low	Alluvium	Mixed

1. Computed by difference.

a. Piute Spring.

b. Analysis by Nevada Department of Health; total dissolved solids, 1,275 ppm.

Water quality and its relation to the ground-water system -- The water of best quality has had a minimum contact with the rocks and soil. In Nevada, the best-quality ground-water is usually near the sources of recharge or in the mountains. Piute Spring fits this general pattern (specific conductance, 479 micromhos), but the other two mountain-area samples, from wells 26/64-28d1 and 31/65-8b1, have high specific conductances. These high values probably are caused by the very slow rate of movement and long-term contact with the granitic rock.

No samples were obtained from wells or springs in Eldorado Valley. However, the Colorado River Commission supplied the results of an analysis of water from well 24/63-29a1 made by the Nevada Department of Health. The water had a dissolved-solid content of 1,275 ppm and therefore would have a specific conductance higher than any of the other samples listed in table 4. The operator of the gravel pit, three miles south of Railroad Pass on U. S. Highway 95, reports that a test well was constructed at that site (well 24/63-23c1 in table 6) but produced only salty water. It is probable that salty water is widely distributed throughout most of the valley.

Development

Present Development

The present utilization of ground- and surface-water resources of the report area is small. As pointed out previously, small amounts of water are used for public supply, domestic, and stock-watering purposes. No regularly used wells are in Eldorado Valley; most are shallow, bedrock, domestic wells at Nelson. In Piute Valley, most of the wells are scattered throughout the northern half of the valley. Most are stock wells. The town of Searchlight is the largest user in the valley and is served by four wells. The southern half of Piute Valley has very few wells. For stock-watering purposes, water from Piute Spring is piped to several nearby stock tanks. Water is also piped from Malpais Springs, 15/17-23a1 (Calif.), to the YKL Ranch for stock watering.

Potential Development

The ground-water resources, as defined by the perennial yield of each of the subareas, are greatly limited. Insufficient water is available, and then at considerable depth, for the development of irrigation on other than a very small scale. Sufficient ground-water, however, is available to support moderate increases in public-supply and stock-watering uses.

The surface-water resources are limited almost entirely to the Colorado River. On the average (1934-64), 14,200 cfs (slightly more than 10 million acre-feet per year) of surface water enters the report area at Hoover Dam. Although most of this flow is appropriated for use downstream by California, Arizona, and Mexico, the Supreme Court of the United States has allotted 300,000 acre-feet per year to Nevada. This water will be utilized through the Southern Nevada Water Supply Project as administered by the Colorado River Commission. It is the Commission's plan, according to Ivan P. Head (oral communication, 1965), to allot 40,000 acre-feet of water for use in Eldorado Valley.

Shamberger (1954) outlined the water needs for southern Nevada; table 5 summarizes the potential for the report area for agriculture. With full development of the land classified as arable, 120,000 acre-feet of water would be needed in Eldorado Valley, 23,000 acre-feet in the adjacent segment of the Colorado River valley, and an unknown amount in Piute Valley. The needs for any potential industrial or governmental development are not known; however, as of 1965 any large amount of low-salinity water would have to be from the only nearby large source -- the Colorado River.

Table 5.--Estimates of present and potential agricultural land use and irrigation-water needs in the Eldorado-Piute Valley area

(Modified from Shamberger, 1954)

Valley	Area	Location	Irrigated land (acres and year)	Land suitable for irrigation (acres)	Potential beneficial consumption: Rate (acre-feet, per acre	Potential beneficial consumption: Total (acre-feet, rounded)
Eldorado	near Dry Lake	--	0 (1965)	17,000	6.8	116,000
Piute	--	--	0 (1965)	(unknown)	--	(unknown)
Colorado River	Big Bend	3 to 6 mi. south of Davis Dam	0 (1953)	500	5.4	2,700
	Fort Mohave	8 to 12 mi. south of Davis Dam	0 (1953)	3,760	5.4	20,000
Total (rounded)				21,000 +		140,000 +

Table 6.--Records of selected wells in the Eldorado-Piute Valley area

Owner and/or name: BLM, Bureau of Land Management
Altitude: Estimated from topographic maps
Measuring point: TC, top of casing; HC, hole in casing

Water level: M, measured; R, reported
Use: PS, public supply; D, domestic; I, irrigation; S, stock; U, unused
Log no. is log number in files of the Nevada State Engineer.

Well number and location	Owner and/or name	Date drilled	Depth (feet)	Diameter of casing (inches)	Principal water-bearing zone (feet)	Altitude (feet)	Measuring point: Description	Measuring point: Above land surface (feet)	Water level: Below measuring point (feet)	Water level: M or R	Water level: Date	Temperature (°F)	Use	Log no.	Remarks
10/21-15c1 [1]	Flamingo well					1,780			(flowing)		4-30-65	96	D		Flows 10 gpm
13/19-33a1 [1]	--					2,300			Dry at 100	M	4-30-65		U		Windmill. Old mine shaft.
23/63-23c1	J. Gornowich	1948	600	8	325-330	1,760			300	R	10-21-58		U	691	Reportedly produced only salt water.
24/63-7d1	W. R. Tompson	1952	1,142	No casing	173-196	1,750			Produced insufficient water				U	2260	Size of hole drilled $12\frac{1}{4}$ inches
24/63-18a1	--		775			1,760			320	R					
24/63-18d1	Harry DeVinney	1966	600	16		1,750							Test		
24/63-20b1	--			16		1,710									Filled to surface. On playa
24/63-29a1	Harry DeVinney	1966	476	12	475-478	1,715			275	R	2-24-66	83	Test		Pumped 920 gpm with a drawdown of 95 feet for 24 hours.
24/63-29b1	W. M. Tewmbley	1964	1,507			1,720									Bedrock at depth 1040 feet.
26/63-13c1	Desert Queen well					3,980			Dry at 150	M	5-01-65		S		Old mine shaft
26/63-13d1	--					3,900			Dry at 125	M	5-01-65		S		Old mine shaft
26/64-10b1	Belle E. Stoughton	1964	120	8	60-120	2,960			74	R	7-22-64		D		
26/64-28a1	--					4,100	TC	2.0	30.65	M	4-30-65	62	U		Old mine shaft Windmill
27/63-10d1	Tecolote well			6		3,040	TC	.2	> 300	M	4-30-65		D,S		Windmill
28/61-36c1	Clarks well	Dug well	30			4,880			15	R	5-01-65		S		
28/62-16a1	Little well		710	6		4,140			459.84	M	4-29-65		S		Windmill and gasoline engine
28/62-27c1	YKL Ranch		920	6		3,930			760	R	4-29-65		D		Logged limestone at 920 feet
28/63-27a1	Clark County - Searchlight Municipal			10		3,680	TC	1	289	R	4-29-65		PS		
28/63-27a2	do	1965	437	16	309-422	3,680			290	R	2-02-65		PS	8037	
28/63-29c1	Brewer well		200			3,550							U		Abandoned
28/63-30a1	Clark County - Searchlight Municipal	1956	366	14	241-260	3,560			134	R	7-01-56		PS	3312	
28/63-34b1	K. P. Weikel	1961	130	8	95-100	3,490			73	R	6-30-61		D		
28/63-35b1	Clark County - Searchlight Municipal	1961	450	8	145-450	3,360	TC		141	R	9-29-61		PS	5154	
28/64-31b1	--					3,320			Dry at 100	M	5-01-65		U		Old mine shaft
28/64-32b1	John Kay	1961	99	8	55- 58	3,200			30	R	1-09-62		Test		Bedrock at 8 ft.
28/65-24c1	Cottonwood Cove Corporation	1955	126	8	93-126	670			37	R	4-23-59		PS	4307	
28/65-28a1	National Park Service	1960	110	12	100-110	1,250			70	R	7-02-60		PS	5025	
29/63-7c1	Stomfie well		485			3,410			420	R	4-29-65		S		
29/63-20b1	Tip top well					3,220			100	R					Old mine shaft
30/62-15c1	Stray Cow well		30			3,050			15	R	4-29-65		S		
30/63-9d1	BLM - Tecolote well		825	6		2,900	HC	.2	700	R	4-29-65	87	S		Windmill. Logged hard sand at 825 feet.
30/64-5a1	BLM - Deep well			4		2,755	TC	1.5	> 500	M	5-01-65		S		Windmill
30/64-19b1	Charles Langdon	1958	500	10		2,650							I		
30/65-31d1	Thomas well	Dug well				1,580			Dry at 30		4-30-65		S		Windmill
31/65-8c1	--	Dug well		36		1,750	TC	.4	29.94	M	4-30-65	67	D		
32/65-15a1	--	Dug well		15		2,400			Dry at 15	M	4-29-65		U		

1. This well is in California.

Table 7. --Drillers' logs for the Eldorado-Piute Valley area

Material	Thick-ness (feet)	Depth (feet)
23/63-23c1		
Sand and gravel	220	220
Clay, brown	105	325
Gravel (salt water)	5	330
Lime	370	700
Clay, blue	40	740
Lime	30	770
Shale and shells	80	850
Clay, sticky, brown	30	880
24/63-2d1		
Clay, yellow	173	173
Gravel and sand, rough	23	196
Clay, brown	788	984
Rock, medium hard	42	1026
Clay, black gummy	116	1142
24/63-29a1		
Sand, fine and brown clay	81	81
Sand, gravel and shale	12	93
Sand, fine and clay	45	138
Sand, medium and clay streaks	28	166
Sand, fine and clay	21	187
Sandstone and shale	25	212
24/63-29a1 (cont.)		
Sand, gravel and sandstone	10	222
Gravel and clay streaks	26	248
Sand, fine and clay	19	267
Clay, sandstone, and sand	160	427
Boulders, black and basalt	48	475
(No lithology reported)	3	478
24/63-29b1		
Clay	380	380
Volcanic debris, black and red	240	620
Clay, brown	60	680
Sand	20	700
Clay, sandy	40	740
Sand	160	900
Volcanics, red and black	80	980
Clay, light tan	20	1000
Sand	40	1040
Rhyolite	467	1507

Table 7.-- (Continued)

Material	Thickness (feet)	Depth (feet)
28/63-27a2		
Rock, red, broken	35	35
Rock, yellow, broken	60	95
Lime, gray	15	110
Rock, yellow	30	140
Rock, red	35	175
Rock, yellow	15	190
Rock, red	25	215
Rock, yellow	90	305
Rock, red	10	315
Rock, brown, hard	20	335
Rock, brown, hard	40	375
Rock, red, hard	47	422
Rock, gray, hard	30	452
28/63-34a1		
Sand, gravel, boulders	14	14
Gravel	6	20
Gravel and lime rock	12	32
Rock	23	55
Limestone, brown and yellow	20	75
Limestone, brown	25	100
Rock, brown and yellow	10	110
Limestone, gray	11	121
Limestone, gray and brown	37	158
Limestone, brown and yellow	27	185
Gravel	5	190
28/63-34a1 (cont.)		
Limestone, brown and yellow	15	205
Lime, gray and pink, muddy	9	214
Limestone, brown, green, and pink	14	228
Limestone, brown and green	6	234
Limestone, gray, hard	7	241
Limestone, gray, soft	19	260
Limestone, gray	42	302
Limestone, gray, green, and brown	10	312
Limestone, gray and green	11	323
Limestone, gray, green and brown	2	325
Lime, gray and clay	18	343
Limestone, gray, hard	17	360
Limestone, gray, hard	6	366
28/63-35b1		
Andesite	287	287
Granite, blue	22	309
Talc	3	312
Andesite; water in small fractures	138	450

Table 7.-- (Continued)

Material	Thickness (feet)	Depth (feet)
28/65-24cl		
Sand and gravel	9	9
Boulders and gravel	13	22
Lime, hard	24	46
Sand, fine	47	93
Sand, coarse	12	105
Sand and gravel	21	126
28/65-28al		
Sand and gravel, loose	57	57
Sand, gray, loose	53	110

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WATER RESOURCES - RECONNAISSANCE SERIES

Report no. on fig. 1	Valley	
1	Newark (out of print)	
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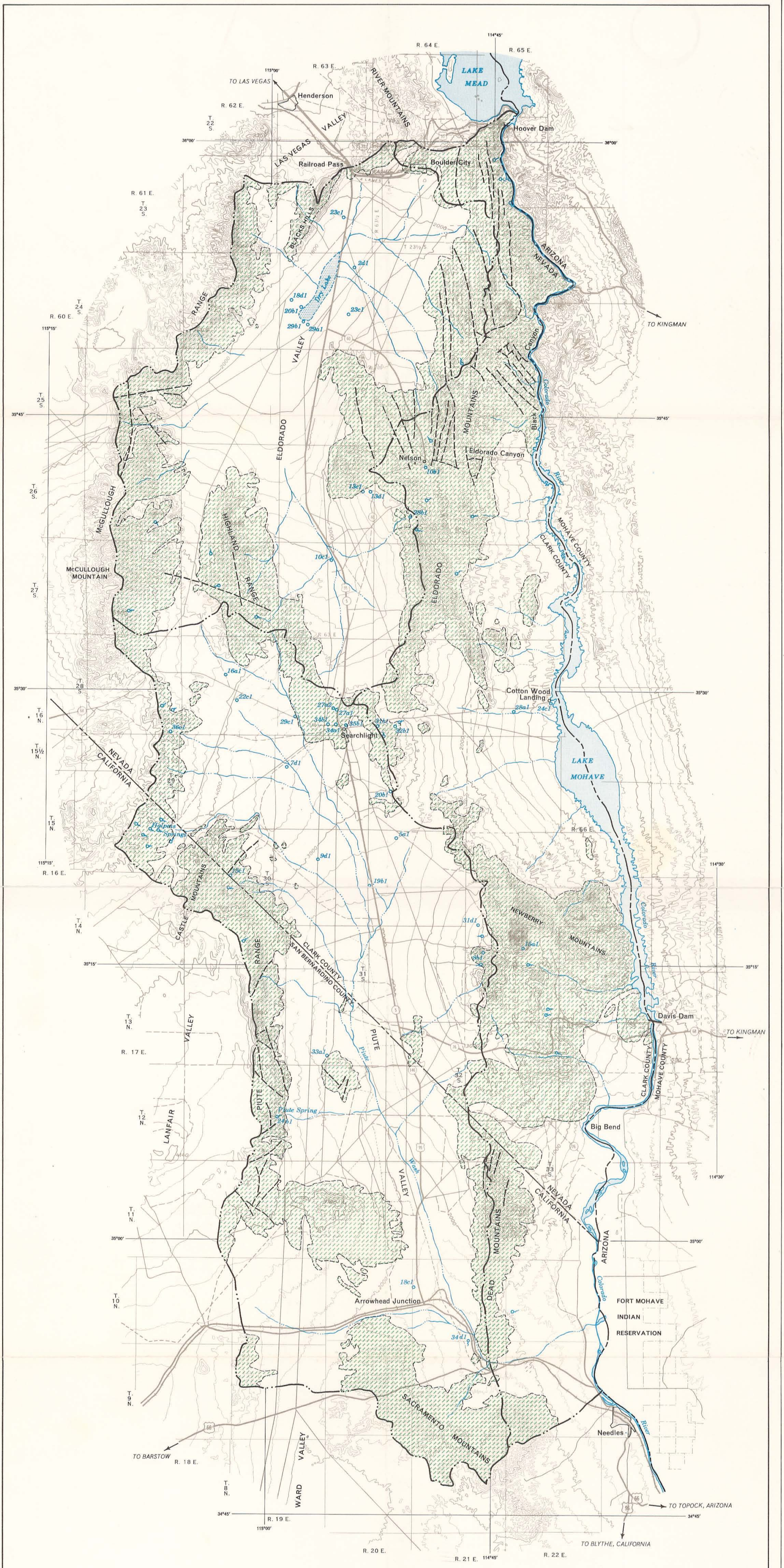
5	Imlay area (out of print)	
6	Diamond (out of print)	
7	Desert	
8	Independence	
9	Gabbs	
10	Sarcobatus and Oasis	
11	Hualapai Flat	
12	Ralston and Stonecabin	
13	Cave	
14	Amargosa	
15	Long	Surprise
	Massacre Lake	Coleman
	Mosquito	Guano
	Boulder	
16	Dry Lake and Delamar	
17	Duck Lake	
18	Garden and Coal	
19	Middle Reese and Antelope	
20	Black Rock Desert	
	Granite Basin	
	High Rock Lake	
	Summit Lake	
21	Pahranagat and Pahroc	
22	Pueblo	Continental Lake
	Virgin	Gridley Lake
23	Dixie	Stingaree
	Fairview	Pleasant
	Eastgate	Jersey
	Cowkick	
24	Lake	
25	Coyote Spring	
	Kane Spring	
	Muddy River Springs	
26	Edwards Creek	
27	Lower Meadow	Patterson
	Spring (near Panaca)	Panaca
	Eagle	Clover
	Dry	
28	Smith Creek and Ione	
29	Grass (near Winnemucca)	
30	Monitor, Antelope, and Kobeh	
31	Upper Reese	
32	Lovelock	
33	Spring (near Ely)	
34	Snake	
	Hamlin	
	Antelope	
	Pleasant	
	Ferguson Desert	
35	Huntington	
	Dixie Flat	
	Whitesage Flat	



EXPLANATION

PLIOCENE TO RECENT — Alluvium — TERTIARY AND QUATERNARY

Unconsolidated lens of gravel, sand, silt, and clay of low to moderate permeability, derived by erosion from the adjacent mountains

PRECAMBRIAN TO TERTIARY — Consolidated rocks

Igneous, metamorphic, and sedimentary rocks, mostly granite, gneiss, and volcanic flows of low permeability

Scale in miles: 0 2 4 6

Contact

Boundary of areas; in most cases drainage divide

23c1 — Well and number

Spring

Fault, approximately located

Base from Army Map Service 1:250,000 series:
Las Vegas (1954); Kingman (1954), and Needles (1962)

Hydrogeology by F. Eugene Rush and Charles J. Huxel, Jr., 1965; partly adapted from Longwell (1963), Bowyer and others (1958), and Callaghan (1939)

PLATE 1.—GENERALIZED HYDROGEOLOGIC MAP OF THE ELDORADO-PIUTE VALLEY AREA, NEVADA AND CALIFORNIA